Lyons Ferry Hatchery Evaluations: Fall Chinook Salmon Annual Report (2021 Return/2022 Releases)

Authored by

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Executive Summary

This report summarizes activities by the Washington Department of Fish and Wildlife's (WDFW) to evaluate the Lyons Ferry Fall Chinook Salmon Program that includes 2021 spawning activities and 2022 releases of yearlings and subyearlings.

The estimated run size of natural-origin (NOR) fall Chinook salmon to reach Lower Granite Dam (LGR) was 7,089 fish $\geq$ 57 cm fork length and 868 fish 30- <57 cm fork length. The remaining portion of the run consisted of 24,606 hatchery-origin (HOR) fish $\geq$ 57 cm and 5,350 HORs 30-< 57 cm. Nearly all HOR fall Chinook salmon were from Lyons Ferry Hatchery (LFH), the Fall Chinook Acclimation Project (FCAP), Idaho Power Company (IPC), and Nez Perce Tribal Hatchery (NPTH) releases. The estimated stray rate of out-of-basin fish to LGR in 2021 was estimated at ~0.8%.

During 2021, based on the final number of fish processed at LFH for the season, WDFW collected 2,467 fish at LGR for broodstock, monitoring and evaluation of our hatchery releases, and to estimate the run composition at LGR.

In 2021, LFH staff spawned 1,216 females for an estimated total green eggtake of 4,989,169; numerically more than full production goals listed in the 2018-2027 *United States v. Oregon* Management Agreement, but well within precision (+/- 10%) levels expected from artificial production programs. However, LFH experienced higher than normal egg loss (23.9%) compared to most years (3-5%), and as such *US v Oregon* Priorities #10 and #11 were not filled, and Priority #9 was short by ~183,000 fish. At the end of the season, 89 females and 55 males were returned to the Snake River to spawn naturally. Of the 597 males spawned at LFH, 453 were used multiple times to minimize the use of jacks, and to incorporate larger, older fish in the broodstock.

The estimated proportion of NOR fish in all LFH and NPTH broodstock (pNOB), as determined from run-reconstruction methodologies or tissue sampled collected from spawned fish at both spawning facilities was 27.0% and 25.0%, respectively.

In 2022, hatchery staff released yearling and subyearling fall Chinook into the Snake River at LFH. However, due to the production shortage from the high egg loss, no subyearling releases occurred in the Grande Ronde in 2022. Both WDFW release groups at LFH (subyearling and yearling) were represented by a coded wire tag (CWT) group as identified in the *United States v. Oregon* production tables, and each also received passive integrated transponder (PIT) tags to monitor survival and migration rate through the hydro system.

Beginning the week of 18 October 2021, staff conducted fall Chinook salmon redd surveys in the lower Tucannon River. A total of 369 redds (fall Chinook and Coho) were counted and an additional 21 redds were estimated due to landowner restrictions. Total estimated fall Chinook

salmon redds equaled 240. Based on three fish/redd, the estimated number of fall Chinook spawners in the Tucannon River in 2021 was 719. Of the estimated total fall Chinook spawning escapement, 22% were recovered and sampled.

In the spring of 2022, a smolt trap was operated on the Tucannon River to estimate juvenile production of fall Chinook salmon, as well as other species. Captures of fall Chinook salmon passing the smolt trap were expanded by trapping efficiencies and for redds that occur below the smolt trap. Total fall Chinook salmon emigrating from the Tucannon River was estimated at 42,657. Productivity (smolts/redd) from spawning was estimated at 178 smolts/redd.

In 2021, we estimate that a minimum of 5,785 (21.1%) returning adults and jacks that were from WDFW releases contributed to the LSRCP project area mitigation goal (18,300 fish). This estimate includes returns to LGR, and total fish estimated that remained between Ice Harbor Dam and LGR based on PIT Tag conversions. We estimate that a minimum of 8,599 (9.4%) returning adults/jacks that were from WDFW releases contributed to the total LSRCP mitigation objective (91,500 fish). This estimate includes all returns to the Snake River Basin and fully expanded recoveries outside of the Snake River.

Fall Chinook salmon reared at LFH and released into the Snake River at LFH or in the Grande Ronde River (GRR) contributed to multiple fisheries (troll, sport, net) within the ocean and in the Columbia River in 2021. Of the total returns in 2021, harvest from the various ocean and Columbia River fisheries accounted for ~36% of the return.

Endangered Species Act (ESA) section 10 (a)(1)(A) Permit # 16607 was revised in the summer of 2018 and is now referred to as permit # 16607-2R (amended). Overall, we were within allowances of direct take of listed Snake River fall Chinook salmon (SRFCH) for adult returns in 2021 and juvenile releases in 2022. However, while actual “takes” have been estimated, they are not being reported at this time in this report as WDFW and NPT are currently working with NOAA Fisheries on a new Section 10 “Take” Table that will be easier to populate and interpret by everyone. All calculated “takes” for the program that have occurred from 2019-2021 will be reported in future reports.

Acknowledgments

The Lyons Ferry Fall Chinook Salmon Hatchery Evaluation Program is the result of work by many individuals within the WDFW Fish Program. We want to thank all those who contributed to this program.

We would like to thank the Snake River Lab staff: Todd Miller, Michael Gallinat, Dane Kiefel, Jule Keller, Lance Ross, Jacob Chung, Addie Donohue, Morgan Kroeger and staff from the Dayton Fish Management office and the Clarkston Field office for their help in collecting fall Chinook data.

We thank all the hatchery personnel at LFH for their cooperation with sampling and providing information regarding hatchery operations. Thanks also to Andrew Claiborne (WDFW) and his staff at the scale aging lab in Olympia for aging scales collected at LFH, LGR, and Nez Perce Tribal Hatchery for the run reconstruction analysis and profiling the age of broodstock.

We especially appreciate the efforts of Darren Ogden (NOAA Fisheries) and the crew at LGR for trapping, tagging, and documenting fall Chinook salmon for transport to LFH. We also thank Bill Young (NPT) and Stuart Rosenberger (Idaho Power) for their assistance in estimating the run composition at LGR for the 2021 run year, and Ben Sandford (NOAA) for bootstrapping the data, providing confidence intervals around the estimates.

We thank Alf Haukenes (WDFW) and Rod Engle (USFWS) for reviewing a draft of this report and providing valuable comments.

Finally, and most importantly, we thank the U.S. Fish and Wildlife Service, Lower Snake River Compensation Plan Office, for providing funding and support for this program.

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Introduction

This report summarizes activities by the Washington Department of Fish and Wildlife's (WDFW) Lyons Ferry Hatchery (LFH) Fall Chinook Salmon Evaluation Program to include BY 2021 spawning, and both yearling and subyearling releases at LFH or in the Grande Ronde River that occurred in 2022. WDFW's Snake River Lab (SRL) evaluation staff completed this work with federal fiscal year 2021/2022 funds provided through the U.S. Fish and Wildlife Service (USFWS), under the Lower Snake River Compensation Plan (LSRCP).

Definition of LSRCP Project Area and Measurement of Goal

The LSRCP project area starts at Ice Harbor Dam (IHR) extending to Lower Granite Dam (LGR) and is inclusive of the Walla Walla Basin, a Columbia River Basin tributary in SE Washington adjacent to the Snake River basin. This area is inclusive of WDFW steelhead and spring Chinook programs for the LSRCP program (USFWS 2020). Measurement of the LSRCP fall Chinook salmon program goal is for adults and jacks returning ***to*** the project area which starts at IHR.

Program Goals and Objectives

The Snake River fall Chinook (SRFCH) program at LFH began in 1984 after construction of LFH was completed and is part of the LSRCP program authorized by Congress in 1976. The purpose of the LSRCP is to replace adult salmon and steelhead trout lost by construction and operation of four hydroelectric dams on the Lower Snake River in Washington. Specifically, the stated purpose of the plan was:

> *"…[to]…. provide the number of salmon and steelhead trout needed in the Snake River system to help maintain commercial and sport fisheries for anadromous species on a sustaining basis in the Columbia River system and Pacific Ocean" (NMFS & USFWS 1972 pg. 14.)*

Subsequently in 1994, additional authorization was provided to construct juvenile acclimation facilities for SRFCH (Fall Chinook Acclimation Project – FCAP) that would:

> " … protect, maintain, or enhance biological diversity of existing wild stocks."

Numeric mitigation goals for the LSRCP were established in a three-step process (COE 1974). First, the adult escapement that occurred prior to construction of the four dams was estimated.

Second, an estimate was made of the reduction in adult escapement (loss) caused by construction and operation of the dams (e.g., direct mortality of smolts resulting in reduced adult abundance and loss to mainstem spawning habitat). Last, a catch to escapement ratio was used to estimate the future production that was forgone in commercial and recreational fisheries as result of the reduced spawning escapement and natural production.

To determine the LSRCP SRFCH mitigation goal, the escapement to the Snake River below Hells Canyon Dam (HCD) prior to construction of the four lower Snake River dams was estimated at 34,400. Lower Snake River dam construction and operation was expected to reduce the spawning escapement in two ways: 1) the slack water reservoirs created by the dams was expected to eliminate spawning area for 5,000 adults, and 2) 15% of the smolts migrating past each dam were expected to die (48% cumulative mortality). These factors were expected to reduce the SRFCH adult escapement by 18,300, which in turn became the adult mitigation goal for the program. Further, this reduction in natural spawning escapement was estimated to result in a harvest reduction to areas outside of the Snake River Basin: 1) coast-wide commercial/tribal harvest of 54,900 adults, and 2) recreational fishery harvest of 18,300 adults (Table 1). In summary, the expected total number of adults to all possible areas that would be produced as part of the LSRCP mitigation program was 91,500.

Table 1. Fall Chinook salmon LSRCP adult [a] return goals and/or assumed objectives.

Component	Number of adults
Escapement to project area goal	18,300
Outside of Snake River Basin Commercial/Tribal harvest objective	54,900
Outside of Snake River Basin Recreational harvest objective	18,300
Total Hatchery Origin (HOR) fish	**91,500**
Maintain Natural Origin (NOR) population	**14,363**

[a] As defined in the LSRCP document, "adults" include adults and jacks, but not minijacks.

Since 1976 when the LSRCP was authorized, many of the parameters and assumptions used to size the hatchery program at LFH and estimate the magnitude of benefits have changed.

- The survival rate required to deliver a 4:1 catch to escapement ratio has been less than what was originally assumed, and this has resulted in fewer adults being produced.
- The listing of SRFCH and Snake River steelhead under the Endangered Species Act (ESA) has resulted in significant curtailment of commercial, recreational, and tribal fisheries throughout the ocean and mainstem Columbia River. This has resulted in a higher percentage of the annual hatchery run returning to the project area than was originally expected.

- Currently, three hatchery programs artificially propagate SRFCH. Two of the programs, LSRCP (includes LFH and FCAP) and Nez Perce Tribal Hatchery (NPTH), are integrated programs aimed at increasing natural-origin (NOR) fish abundance and harvest using supplementation and harvest mitigation releases. Fish released at LFH, consist of both subyearling and yearling releases while the Grande Ronde River, FCAP facilities, and NPTH releases are subyearlings only starting with BY2018 (*United States v. Oregon* 2018). Information about the FCAP and NPTH programs are presented by the NPT in their annual reports to BPA and LSRCP and are not provided here. The third program, administered by the Idaho Power Company (IPC), is primarily mitigation for lost production due to construction of the Hells Canyon Dam Complex (HCC), and consists of subyearling releases in the Salmon River (Idaho) near Hammer Creek. Releases from all these programs occur at 10 locations throughout the Snake River basin, with most releases located above LGR (Figure 1). All programs are highly coordinated in their operations, including broodstock collection at LGR and egg/juvenile fish transfers among facilities. One out-of-basin LSRCP hatchery facility is used (Irrigon Hatchery in Oregon) in addition to the in-basin facilities and acclimation sites.

- Mark/Tag types and quantities have been adopted under the 2018-2027 *United States v. Oregon* Management Agreement (*United States v. Oregon* 2018 – Table 2). At full production levels, not including NPTH production, ~53% of the hatchery-origin (HOR) produced fish are marked with an adipose (AD) fin clip and a portion are tagged with coded wire tags (CWT). If changes to marking/tagging occurs, there is a notification process that needs to be followed per permit #16607 – 2R issued to WDFW from NOAA-Fisheries and amended in 2018 (NMFS 2018).

HOR Return Goals

- In the early 2000s, as part of developing a management plan for SRFCH, Snake Basin co-managers developed an adult return goal for HOR fall Chinook to the Snake Basin. This adult return goal combined the various mitigation goals from the hatchery programs into a combined number for the basin. The LSRCP funded hatchery production has an established adult mitigation goal of 18,300 adults to the project area (above IHR) and the NPTH program has an adult return goal of 3,750 adults above Lower Monumental Dam. The IPC funded production has mitigation responsibility of releasing 1,000,000 juveniles annually, with no adult goal. For the combined goal, we added the current LSRCP funded program releases (LFH – yearling and subyearling releases (including the Grande Ronde release) and all FCAP) – Note: a combined SAR of 0.56% would return 18,300 to the project area from all LFH and FCAP releases. Using the same survival assumptions for the current IPC program would result in an adult return of 5,600.

Combining these two with the NPTH adult goal (3,750) would result in a total HOR goal of 27,650.

NOR Return Goals

- Achieve ESA delisting by attaining interim population abundance in the Snake River Evolutionary Significant Unit (ESU) of at least 3,000 NOR SRFCH spawners (adults and jacks), with no fewer than 2,500 distributed in the mainstem Snake River (as recommended by the Interior Columbia Technical Recovery Team).
- Interim short-term restoration goal is to achieve a population of 7,500 NOR SRFCH (adults and jacks) above IHR
- Long term restoration goal is to achieve a population of 14,363 NOR SRFCH (adults and jacks) above IHR.

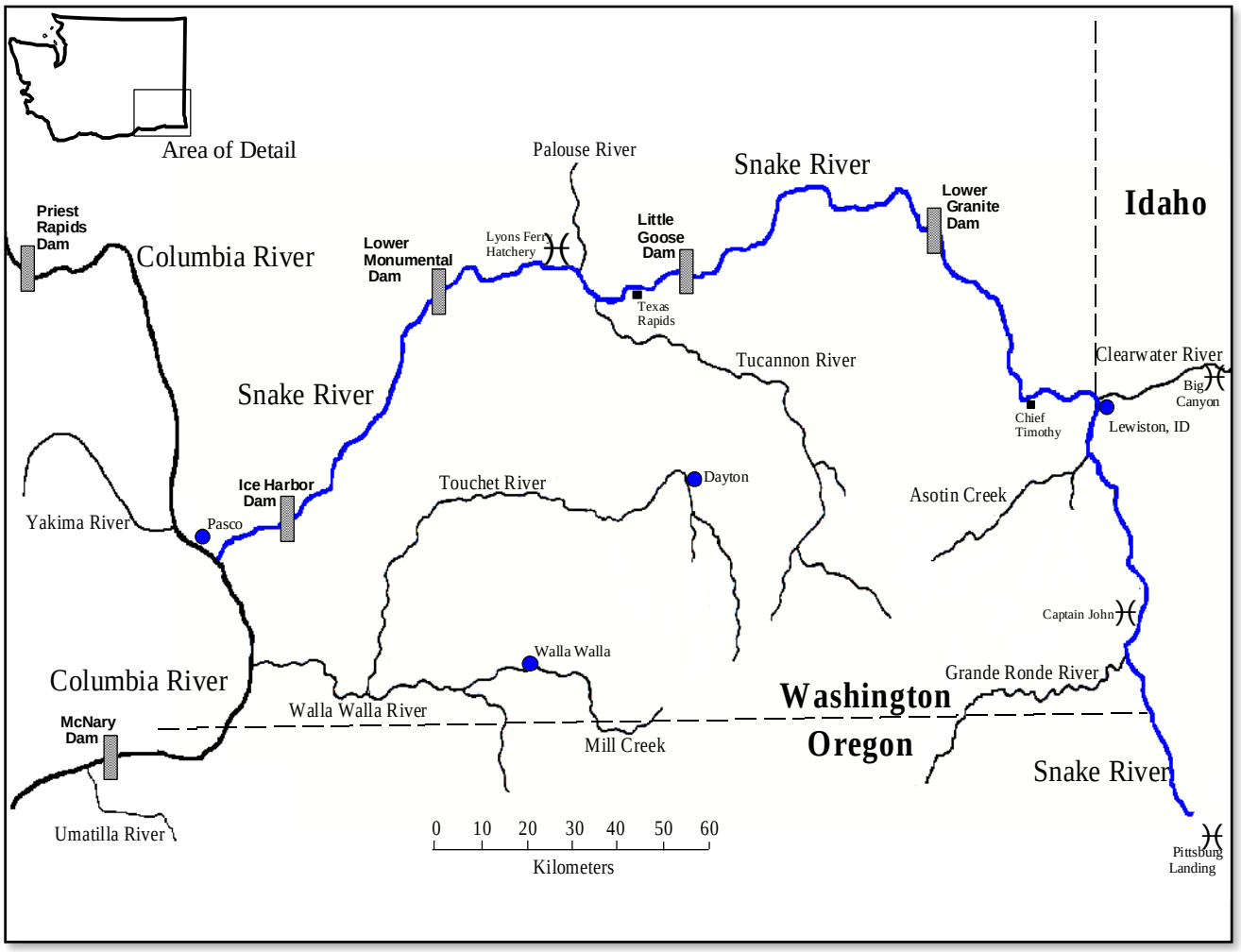

Figure 1. The Lower Snake River Basin showing locations of LFH, some of the SRFCH acclimation sites, and major tributaries in the area.

Table 2. SRFCH production priorities for the LSRCP at LFH, FCAP and IPC per the *US v. Oregon Management Agreement* for brood years 2018-2027.

Priority	Rearing facility	Release Number	Age	Release location	Marking/Tagging [1]
1	LFH	450,000	1+	On-station	450K ADCWT
2	LFH	450,000	0+	Captain John	200K ADCWT, 250K no clip
3	LFH	450,000	0+	Big Canyon	200K ADCWT, 250K no clip
4	LFH	500,000	0+	On-station	200K ADCWT, 300K no clip
5	LFH	400,000	0+	Pittsburg Landing	200K ADCWT, 200K no clip
6	LFH	200,000	0+	Captain John 2	200K ADCWT
7	LFH	200,000	0+	Big Canyon 2	200K ADCWT
8	LFH	200,000	0+	Pittsburg Landing 2	200K ADCWT
9	Irrigon	1,000,000	0+	Salmon River [2]	200K ADCWT, 800K no clip
10	Irrigon	200,000	0+	Grande Ronde River	200K ADCWT
11	LFH	200,000	0+	On-station	200K no clip
TOTAL	**Yearlings**	**450,000**			
	Subyearlings	**3,800,000**			

[1] For all SRFCH hatchery programs, tissue samples are collected annually from broodstock and incorporated into a parentage-based tagging (PBT) baseline. The hatchery programs effectively 'tag' ~90-100% of annual releases. All release sites and groups will be PIT tagged and differentially PBT marked/tagged. PBT will be utilized for all fish, including those marked "no clip". No clip means no adipose fin clip and no CWT wire mark.

[2] Beginning in 2018, the releases of subyearlings at Hells Canyon Dam were moved to the Salmon River. Several Parties are actively participating in the re-licensing of Idaho Power Company's Hells Canyon Complex and its operations. Idaho Power Company's mitigation responsibilities, including production numbers and release locations are a subject of these discussions.

2021 Fall Chinook Salmon Run Size and Composition

Returns to LGR and Composition of Fish Returning to LGR

Chinook salmon (spring, summer, and fall runs) were counted at the LGR counting window in 2021. Fish are visually measured and grouped by total length (TL) at fish passage windows. Window counts (day and night) estimated 41,416 SRFCH ($\geq$ 30 cm TL) reached LGR in 2021 (Figure 2), which includes 10,058 "jacks" by size (30 cm-55 cm TL). Chinook salmon passing LGR after 17 August are designated as SRFCH based on arrival date, which may be inaccurate because of the overlap between the summer Chinook and fall Chinook runs. In addition, fish counts do not include fish less than 30 cm long or adjust for fish that crossed the dam and fell back through the juvenile bypass system, spillway, turbines, or locks, some of which may have re-ascended the ladder and were double counted.

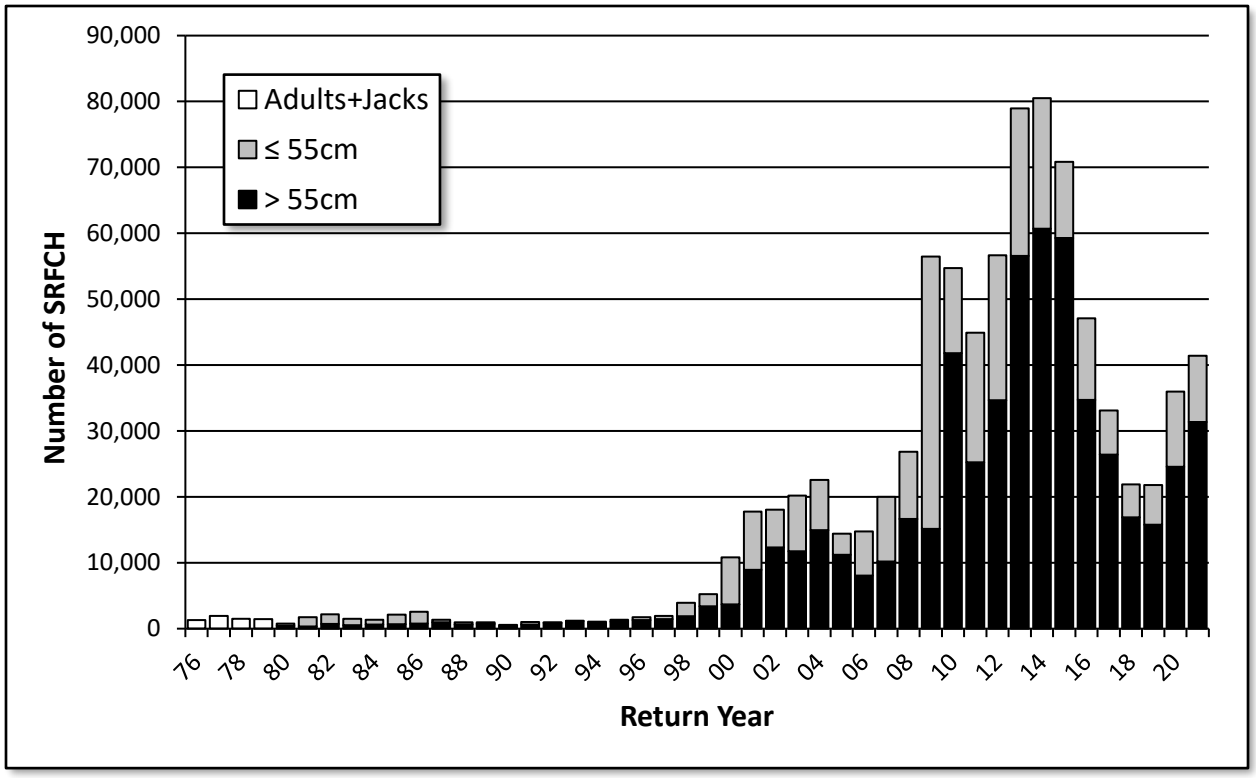

Figure 2. Snake River Fall Chinook salmon window counts at LGR, 1976-2021.

The SRFCH run reconstruction technical team annually estimates the run to LGR and consists of staff from WDFW, NPT, IPC, NOAA, and the Columbia River Inter-Tribal Fish Commission (CRITFC). The estimates derived were bootstrapped (Ben Sandford of NOAA Fisheries, personal communication) with confidence intervals applied to the point estimates (Table 3). The SRFCH run reconstruction team uses a slightly different length criteria (30-56 cm fork length, and ≥ 57 cm) compared to the COE window counts. This was done based on recovered CWTs that suggested the size range should be modified to better describe adult, jack, and mini-jack returns. The SRFCH run reconstruction technical team (Bill Young – NPT, Joe Bumgarner and Jenna Fortier – WDFW, Stuart Rosenberger – IPC, John Powell – IDFG, Ben Sandford – NOAA Fisheries) estimated 37,913 adult, jack, and mini-jack (including males <57 cm) SRFCH reached LGR in 2021. For adults and jacks only, an estimated 21.0% were natural-origin, 78.2% were in-basin hatchery-origin, and 0.8% were out-of-basin hatchery-origin. The final run estimate to LGR was 8.5% less than window count estimates documented at www.fpc.org. Females, regardless of size, were summarized together and males were summarized according to fork length (30-56 cm (jacks) and ≥ 57 cm (adults). The data is grouped by total age as requested by the *U.S. v. Oregon* Technical Advisory Committee (TAC) for forecasting future runs. The data does not specifically show true jacks because age 2 fish consist of minijacks (0-salt yearlings), and jacks (1-salt subyearlings) and age 3 fish consist of jacks (1-salt yearlings) and adults (2-salt subyearlings).

Table 3. Estimated composition, standard errors, and confidence intervals for Snake River fall Chinook salmon, males (M) and females (F) reaching LGR during 2021.

Estimates					Bootstrap standard error					Bootstrap 95% Confidence Interval (Upper CI, Lower CI)				
Total Run by Origin														
Origin	**F**	**M ≥57cm**	**M <57 cm**	**Total ≥57cm**	**Origin**	**F**	**M ≥57 cm**	**M <57 cm**	**Total ≥57cm**	**Origin**	**F**	**M ≥ 57cm**	**M <57 cm**	**Total ≥57 cm**
Total wild	2,979	4,110	868	7,089	Total wild	402	463	453	601	Total wild	2039, 3605	3228, 5013	-157, 1671	5775, 8131
Total hatchery	11,427	13,179	5,350	24,606	Total hatchery	436	478	447	609	Total hatchery	10637, 12364	12293, 14128	4618, 6329	23499, 25905
Totals	14,406	17,289	6,218	31,695	Totals	209	226	195	199	Totals	13967, 14798	16915, 17778	5826, 6603	31307, 32102
Run by origin and age														
Origin	**F**	**M ≥57cm**	**M <57 cm**	**Total ≥57cm**	**Origin**	**F**	**M ≥57cm**	**M <57cm**	**Total ≥57cm**	**Origin**	**F**	**M ≥57cm**	**M <57 cm**	**Total ≥57 cm**
Wild age 2	3	217	777	220	Wild age 2	15	42	450	44	Wild age 2	-29, 27	128, 292	-205, 1558	128, 300
Wild age 3	1,862	2,581	76	4,444	Wild age 3	180	442	53	470	Wild age 3	1444, 2149	1692, 3446	-51, 156	3455, 5285
Wild age 4	1,017	1,288	14	2,305	Wild age 4	359	224	9	421	Wild age 4	136, 1569	877, 1759	0, 33	1326, 2984
Wild age 5	170	24	0	194	Wild age 5	50	25	0	56	Wild age 5	68, 256	-27, 69	0, 0	72, 288
Wild age 6	0	0	0	0	Wild age 6	0	0	0	0	Wild age 6	0, 0	-1, 0	0, 0	-1, 0
Hat age 2	14	33	4,777	47	Hat age 2	13	34	478	36	Hat age 2	0, 41	0, 114	3960, 5766	0, 131
Hat age 3	1,908	9,144	541	11,052	Hat age 3	218	500	127	536	Hat age 3	1530, 2387	8125, 10057	292, 804	9903, 11996
Hat age 4	8,887	3,787	5	12,674	Hat age 4	428	325	5	536	Hat age 4	8134, 9777	3057, 4349	0, 16	11526, 13712
Hat age 5	496	209	0	705	Hat age 5	97	67	0	121	Hat age 5	346, 717	107, 360	0, 0	516, 986
Hat age 6	10	5	0	15	Hat age 6	9	5	0	10	Hat age 6	0, 31	0, 15	0, 0	0, 39
Stray age 2	0	0	0	0	Stray age 2	0	0	0	0	Stray age 2	0, 0	0, 0	0, 0	0, 0
Stray age 3	0	12	27	12	Stray age 3	0	69	27	69	Stray age 3	0, 0	0, 226	0, 93	0, 226
Stray age 4	49	37	0	86	Stray age 4	62	84	0	103	Stray age 4	10, 234	0, 302	0, 0	33, 430
Stray age 5	10	0	0	10	Stray age 5	10	0	0	10	Stray age 5	0, 30	0, 0	0, 0	0, 30
Stray age 6	0	0	0	0	Stray age 6	0	0	0	0	Stray age 6	0, 0	0, 0	0, 0	0, 0
Stray AWT	0	0	0	0	Stray AWT	0	0	0	0	Stray AWT	0, 0	0, 0	0, 0	0, 0
Stray Wild	0	0	0	0	Stray Wild	0	0	0	0	Stray Wild	0, 0	0, 0	0, 0	0, 0

[a] AWT refers to agency wire tag with a 09 agency code.

Fall Chinook salmon arriving at LGR Dam

The following sections use data collected from HOR and NOR SRFCH handled at the LGR adult trap.

Sex Ratio and Length Frequencies

Out of all the fall Chinook sampled at the LGR trap (expanded by the daily trap rate), 27,074 (64.6%) were considered males (includes adults, jacks and minijacks), and 14,853 (35.4%) were considered female based on their morphological characteristics. Based on the expanded sample, the sex ratio of the fish sampled at LGR was estimated at 1.8:1 M:F. After removal of fish for broodstock, the sex ratio SRFCH upstream of LGR 1.9:1 M:F.

Every salmon trapped at LGR was measured and the number of fish at each length were expanded by the trapping rate on the day they were captured to represent the overall run of fall Chinook salmon at that size during that day (Figure 3). Median fork length for males was 60.0 cm with a mean of 58.2 cm. Median fork length for females was 73.0 cm with a mean of 73.0 cm.

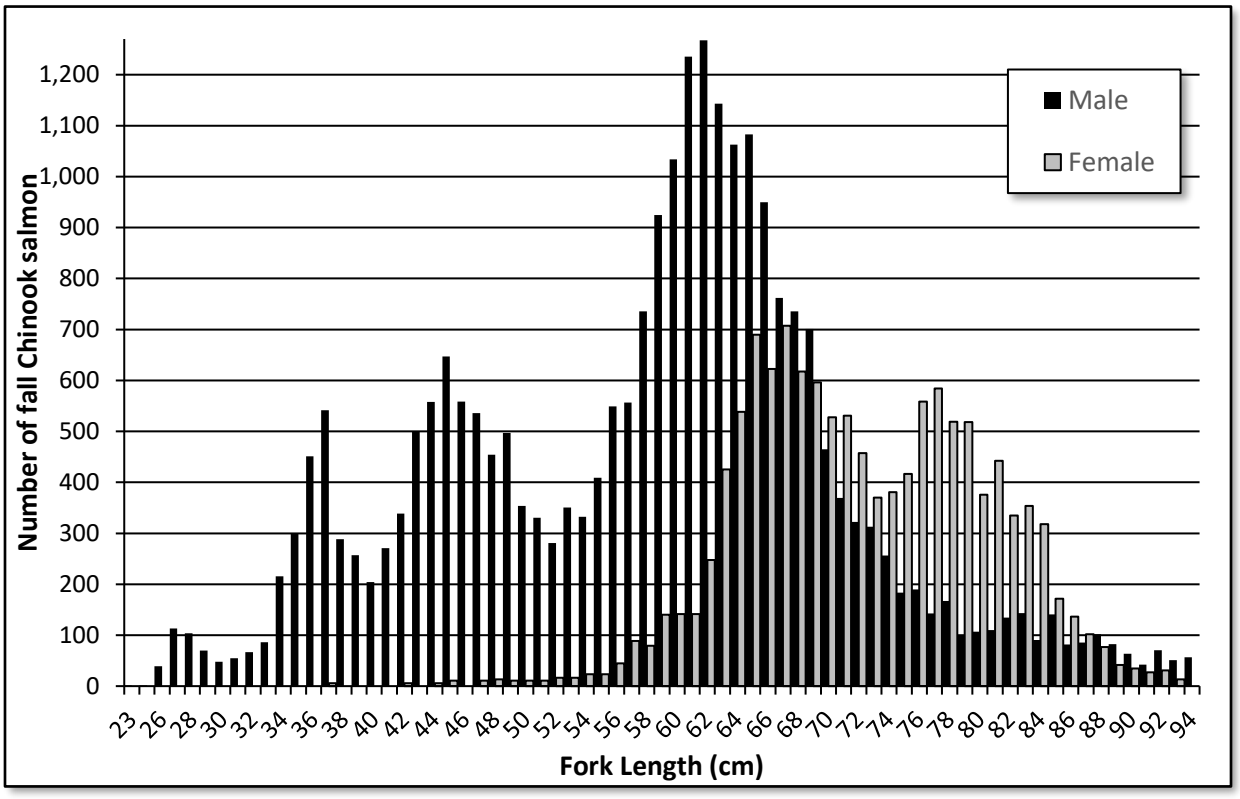

Figure 3. Estimated length frequencies of SRFCH sampled (and expanded by the daily trap rate) at the LGR adult trap in 2021.

Trapping and Broodstock Management 2021

Lower Granite Dam Trapping Operations 2021

In 2021, similar to the last few years, fall Chinook trapping and hauling at LGR began 18 August. Two trapping rates were used during the season (18 Aug – 1 Sept = 70%, 2 Sept – 12 Nov = 18%). These trapping rates were agreed to by the Snake River basin managers in an attempt to address multiple objectives: 1) collect more natural and older aged fall Chinook for broodstock because they return in greater numbers at the front end of the run, 2) which also helps in achieving the 30% pNOB target for the hatcheries, and 3) trying to remain at a 20% or less handle rate impact on natural origin steelhead at LGR (steelhead generally return a little later than the fall Chinook). The arrival timing of males and females collected for broodstock at LGR and hauled to LFH is provided (Figure 4). In 2021, fish collected for broodstock were not completely representative of the overall run to LGR. Broodstock collection goals were met by the end of September, with most of the fish trapped after that time passed upstream for natural spawning. Trapping protocols and changes that occurred in 2021 are presented in Appendix A. Historical trapping rates and operation dates of systematic sampling at LGR are presented in Appendix B. In general, NOAA Fisheries staff anesthetized the salmon, and gather length, sex, fin clip, and the presence of wire or PIT tag. Of the 9,312 salmon trapped at LGR, approximately 26.7% were hauled to LFH and 8.4% were hauled to NPTH to satisfy brood and run reconstruction needs.

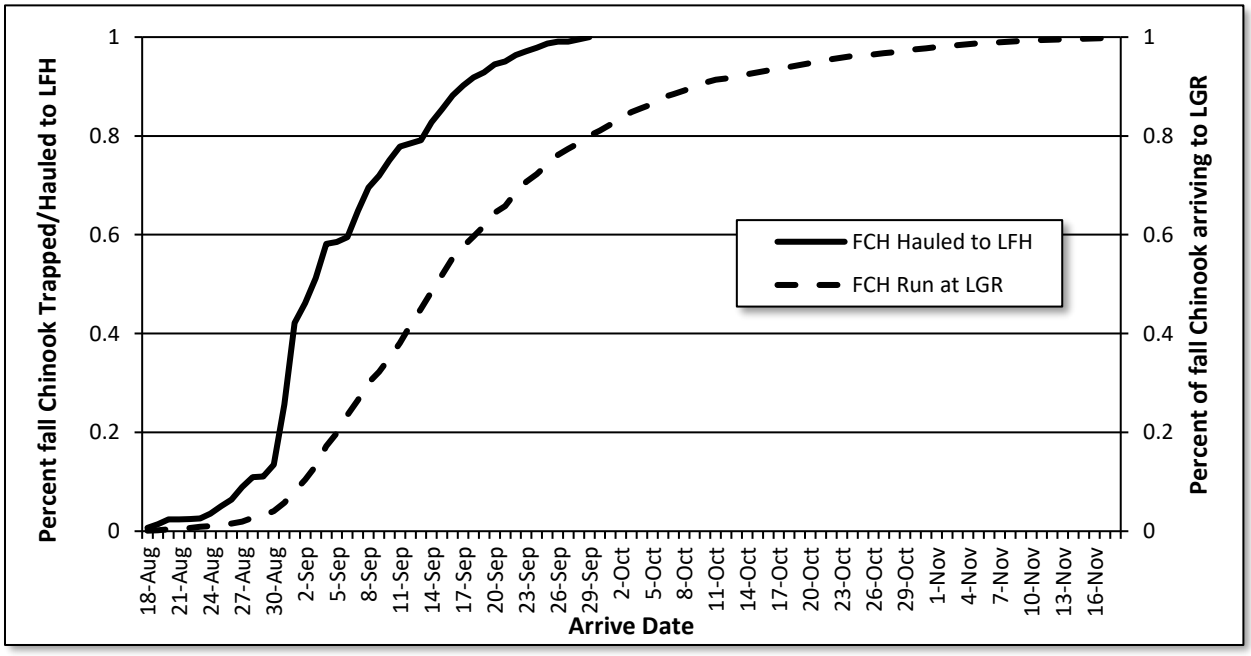

Figure 4. Percent of fall Chinook at LGR that were trapped/hauled to LFH in 2021 compared to the overall return.

Broodstock Collection and Management 2021

In 2021, all fall Chinook salmon collected for broodstock were trapped at LGR. No fish were trapped at LFH or NPTH in 2021. Each year there is a small discrepancy between the reported number of fish collected and hauled to LFH and the number of fish processed and killed at LFH (Table 4). The discrepancies are likely data recording errors at either location.

Table 4. Numbers of fall Chinook initially collected at LGR for broodstock, evaluation, and run construction needs in 2021.

Year	Trap location	Total number collected / hauled for broodstock per LGR records	Total number collected / hauled for broodstock per LFH records	Spawned, killed, or dead in pond fish processed at LFH	Returned to the Snake River at LFH	Difference from LGR LFH number collected / hauled
2021	LGR	2,486	2,467	2,323	144	19

Hatchery Operations 2021

Spawning Operations

Spawning and Egg Take

Fish transported from LGR to the adult holding ponds at LFH had approximately 0.51:1 M:F sex ratio in the adults (≥70 cm), and 10.1:1 M:F sex ratio for fish <70 cm. Most of the fish collected that were < 70 cm (mostly jacks and minijacks) were not intended for broodstock use but were for CWT representation in the run reconstruction. Size criteria for mating males was set at 70 cm to reduce the number of potential jacks (HOR and NOR) used for broodstock. Mate selection and spawning protocols changed weekly according to the number of males ripe during the spawn day and to allow for maximum use of larger, older aged, unmarked/untagged fish. The male:female sex ratio of spawned fish ≥70cm was 0.49:1, and 0.40:1 for spawned fish <70 cm.

The total eggtake and percent egg mortality by year (Table 5), duration and peak of spawning (Figure 5), numbers of fish spawned (Table 6), and the number killed outright or died in the pond are provided (Table 7). Peak spawn timing has shifted approximately 1-week earlier since the program's inception in 1984, and the duration of spawning has decreased compared to early years in the program. Many factors are likely responsible for this shift:

1) Variable trapping locations (IHR, LFH or LGR) over the years or any combination of the three in any given year have provided broodstock.

2) Trapping earlier at LGR in more recent years and bringing brood to LFH earlier could alter spawn timing. Holding water temperatures at LFH are significantly cooler than the Snake River in August and September.

3) Broodstock availability compared to earlier years where the program was often broodstock limited and every fish was needed to fulfill program eggtake goals.

In 2021, seventeen females (four NOR, eleven Snake River HOR, one unknown origin, and one stray HOR by PBT) were non-viable. Natural-origin fish used for broodstock were identified post-spawning based on PIT tags, the lack of a CWT recovered, and PBT results obtained at the end of the season. Composition of fish processed at LFH in 2021 is presented in Appendix C. In 2021, eggtake goals were attained for LFH as required by the production priority table per the 2018-2027 *US v. Oregon* Management Agreement (Table 2). However, due to the higher than normal egg loss at LFH, not all production priorities were met. Priority #9 was slightly short of the goal, and no fish were available for priorities #10 and #11 for the 2021 brood.

Table 5. Egg take and percent egg mortality of fall Chinook salmon at LFH, 1984-2021.

Spawn Year	Total eggtake	Egg mortality to eye-up (%) [a]	Spawn Year	Total eggtake	Egg mortality to eye-up (%) [a]	Spawn Year	Total eggtake	Egg mortality to eye-up (%) [a]
1984	1,567,823	21.6	1997	1,451,823 [c]	5.2	2010	4,619,533	2.7
1985	1,414,342	4.0	1998	2,521,135	5.1	2011	4,723,501	3.5
1986	592,061	4.0	1999	4,668,267	9.4	2012	4,526,108	3.1
1987	5,957,976	3.8	2000	5,143,459	5.9	2013	4,565,660	2.6
1988	2,926,748	3.4	2001	4,734,234	6.4	2014	4,787,615	3.6
1989	3,518,107	5.8	2002	4,910,467	3.6	2015	4,569,472	2.8
1990	3,512,571	8.3	2003	2,812,751	3.1	2016	4,951,188	2.7
1991	2,994,676 [b]	8.3	2004	4,625,638	3.3	2017	4,685,575	5.4
1992	2,265,557 [b]	6.0	2005	4,929,630	3.5	2018	4,754,622	3.3
1993	2,181,879	6.7	2006	2,819,004	3.2	2019	4,670,644	3.1
1994	1,532,404	5.1	2007	5,143,459	3.3	2020	4,603,680	3.1
1995	1,461,500	5.6 [d]	2008	5,010,224	3.7	2021[e]	4,989,169	23.9
1996	1,698,309	4.6	2009	4,574,182	4.7			

[a] Egg mortality includes eggs destroyed due to high ELISA values.

[b] An additional 9,000 eggs from stray females were given to Washington State University.

[c] Does not include loss from 10,000 eggs from stray females given to University of Idaho. The egg loss from strays was 8.63% excluding eggs used in fertilization experiments.

[d] Total egg take includes eggs from one coho female crossed with a fall Chinook salmon.

[e] The high egg mortality in 2021 was isolated to a single bank of incubators at LFH which were used for a portion of eggtake three and all eggtake four. Eggs from take three that were in another bank of incubators were fine and had typical mortality levels. The reason for the high mortality in this single bank of incubators was never determined. Egg survival tests were conducted prior to the 2022 SRFCH spawn in this bank of incubators and mortality was again at a low level and the same as previous years.

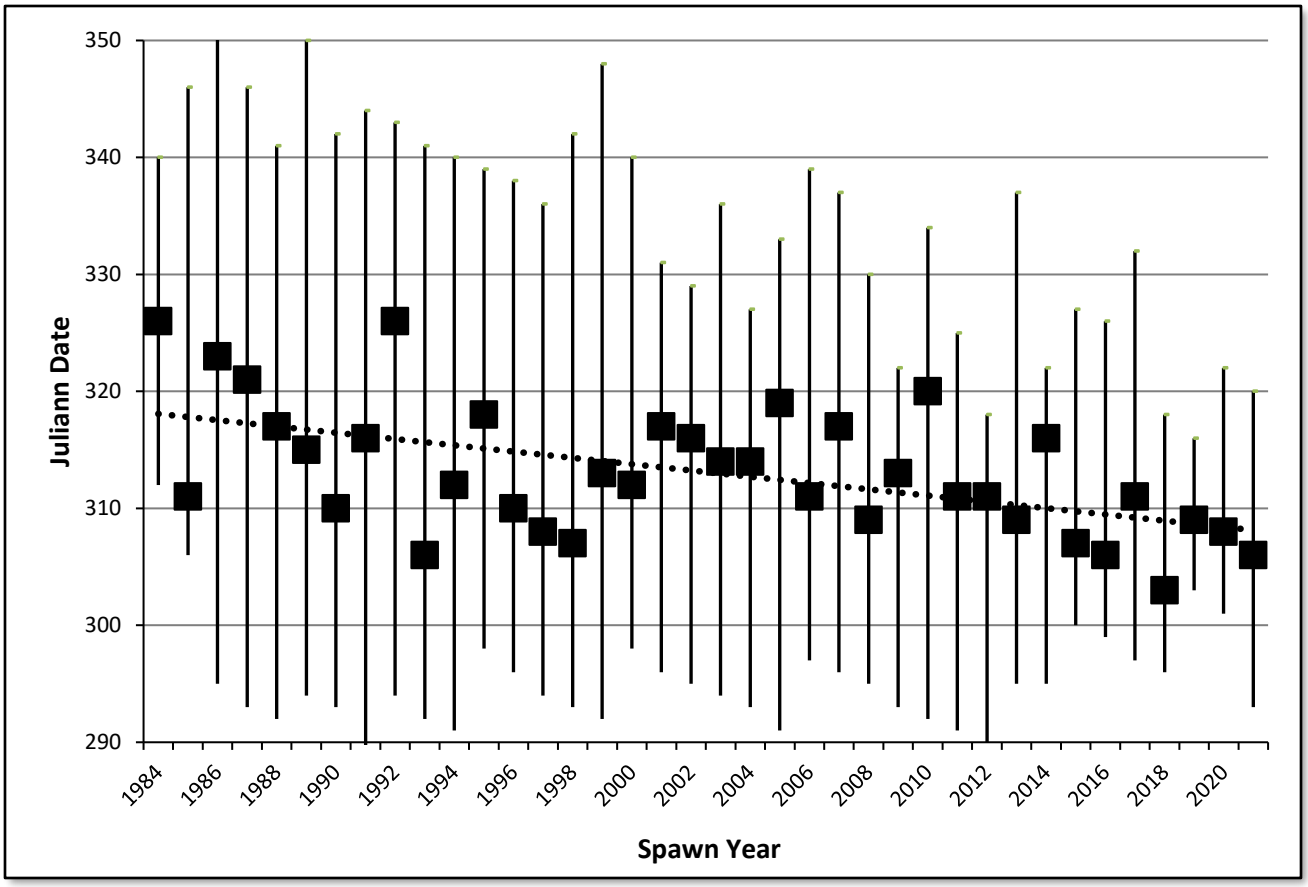

Figure 5. Start, end, and peak spawn days for fall Chinook salmon spawning at LFH, 1984-2021.

Table 6. Spawn dates, numbers of fall Chinook salmon spawned, and weekly egg take at LFH in 2021. Jacks are included with males.

	Males			Females			
Spawn Dates	HOR [ab]	NOR	Unknown Origin	HOR [ab]	NOR	Unknown Origin	Egg Take
20 Oct	53	16		99	31	1	514,820
26 Oct	85	33		229	65		1,133,288
2 Nov	120	47		315	107		1,659,093
8 Nov	131	54	1	204	104		1,415,118
16 Nov	42	18		42	19		266,850
Totals	**431**	**168**	**1**	**889**	**326**	**1**	**4,989,169**

[a] Numbers of fish presented include spawned fish whose progeny were later destroyed.

[b] Numbers include Presumed Snake R, Unknown Hatchery and Stray Hatchery by PBT.

Table 7. Weekly summary and origins of mortality and surplus fall Chinook salmon processed at LFH in 2021.

Week ending	Mortality				Killed Outright					
	LF/Snake R [a]		Other/Unknown [b]		LF/Snake R.		NOR		Other/Unknown	
	F	M	F	M	F	M	F	M	F	M
28 Aug				1						
4 Sept	1	1	2	1						
11 Sept			1	2						
18 Sep	1		1							
25 Sep			2	3						
2 Oct	1	1	1	1						
9 Oct			1	3						
16 Oct			1	2						
23 Oct					5	345	1			18
30 Oct					2	15	1	1		2
6 Nov			3		2	4	2			1
13 Nov					5	2			1	
20 Nov	5	1	2		40	17			4	1
Totals	**8**	**3**	**14**	**13**	**54**	**383**	**3**	**1**	**5**	**22**

[a] Includes known LFH or NPTH origin from CWT or PIT tag detection of Snake River HOR.

[b] Includes undetermined HOR and NOR yearlings by scales, HOR strays by scale, CWTs, regenerated scales, and Lost and No CWTs. Most of these are likely NOR SRFCH, but since a fin clip for PBT is not taken during mortality sampling, origin is undetermined.

Fish Returned to River

Collected broodstock not needed to fulfill broodstock or run-reconstruction needs were returned to the Snake River at LFH on 20 November (Table 8). Fish were scanned for PIT tags, CWT, and presence of an AD clip. Co-managers agreed in-season that these fish could be returned to the Snake River near LFH instead of above LGR due to the expected number released and that it would not affect run reconstruction estimates as the LGR trap had already closed for the season.

Table 8. Estimated composition of SRFCH released into the Snake River near LFH at the end of the season in 2021.

Origin	Marks/Tags	Females	Males + Jacks	Total
Hatchery	Ad Clip/No CWT	35	9	44
Unmarked/Untagged	Ad Intact/No CWT	54	46	100
Totals		**89**	**55**	**144**

Effective Hatchery Population Size

To determine the effective population size of HOR SRFCH production, the number of males and females spawned at both LFH and NPTH were combined. At both hatcheries, sometimes the

larger males were mated with multiple females to mimic more closely what occurs in nature (Hankin 2009). In 2021, a total of 2,056 females and 1,287 unique males were spawned at both facilities combined. Of the 1,287 males spawned, 449 were used multiple times to:

- Increase the number of larger and older aged adults used in crosses,
- increase the number of NOR fish used, and
- reduce the number of jacks used in the broodstock,

Due to the multiple use of males, procedures described in Busack (2007) were used to estimate the effective number of male breeders (N_{em}) at both hatcheries. The estimate of N_{em} at both hatcheries combined in 2021 was 986. Total effective hatchery population (N_e) size was calculated by the following formula:

$$(4 \times (N_{em} \times \text{number of spawned females}))/(N_{em} + \text{number of spawned females}) = N_e$$

$$(4 \times (986 \times 2{,}056)) / (986 + 2{,}056) = 2{,}666$$

For the SRFCH salmon population, the targeted minimum effective population size is 1,000. The critical threshold is thought to be around 500 (personal communication with Craig Busack PhD, NOAA fisheries). Based on the number of spawned fish at both LFH and NPTH since 2005, the program has been above the targeted minimum in all years (Figure 6). The slight reduction in the estimated hatchery effective population size observed since 2011 can be attributed to the multiple use of larger/older males in broodstock at both facilities, with less emphasis on spawning younger and smaller males (at a 1:1 spawning ratio) which was common practice prior to 2011.

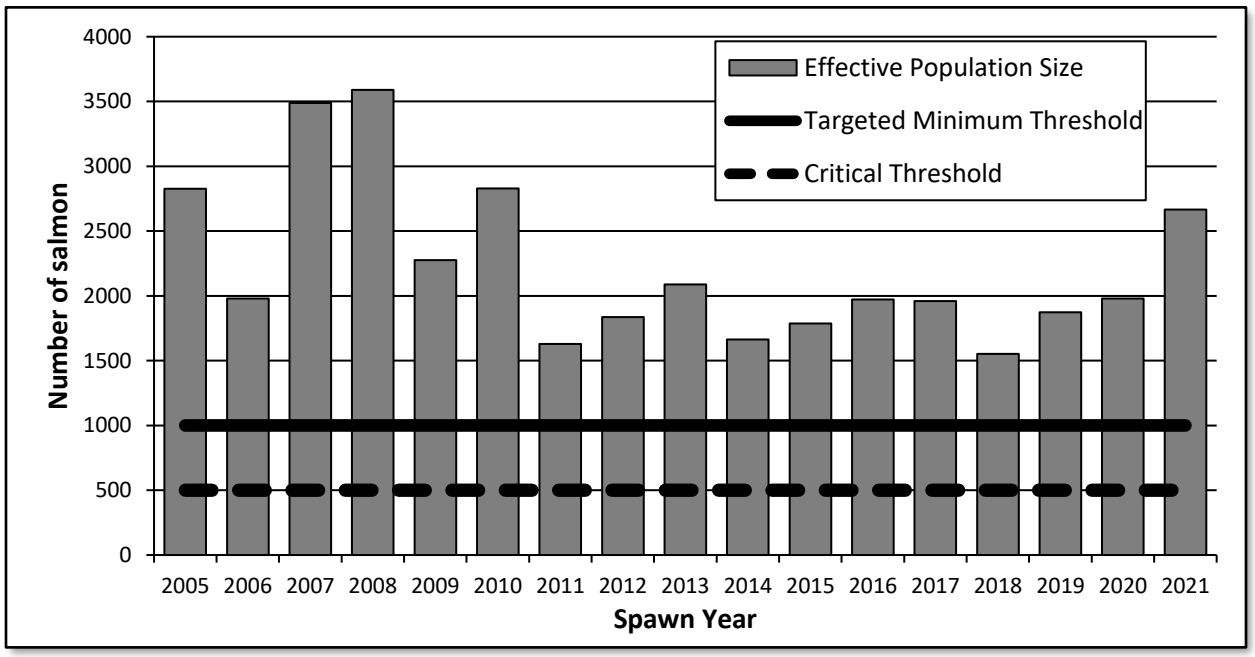

Figure 6. Estimated effective population size of the SRFCH salmon spawned from both LFH and NPTH.

Broodstock Profile

Since 2011, fin tissues have been taken from all fish contributing to broodstock. This was the sixth year of PBT results, in conjunction with CWT and PIT tag recoveries, that were used to determine origin of the broodstock (Figure 7). Since 2012, scales had been taken on all fish contributing to broodstock to determine salt age and rearing type (subyearling, yearling, or reservoir reared subyearlings). However, starting in 2020, scales were not taken on fish with CWTs to reduce data redundancy and save resources.

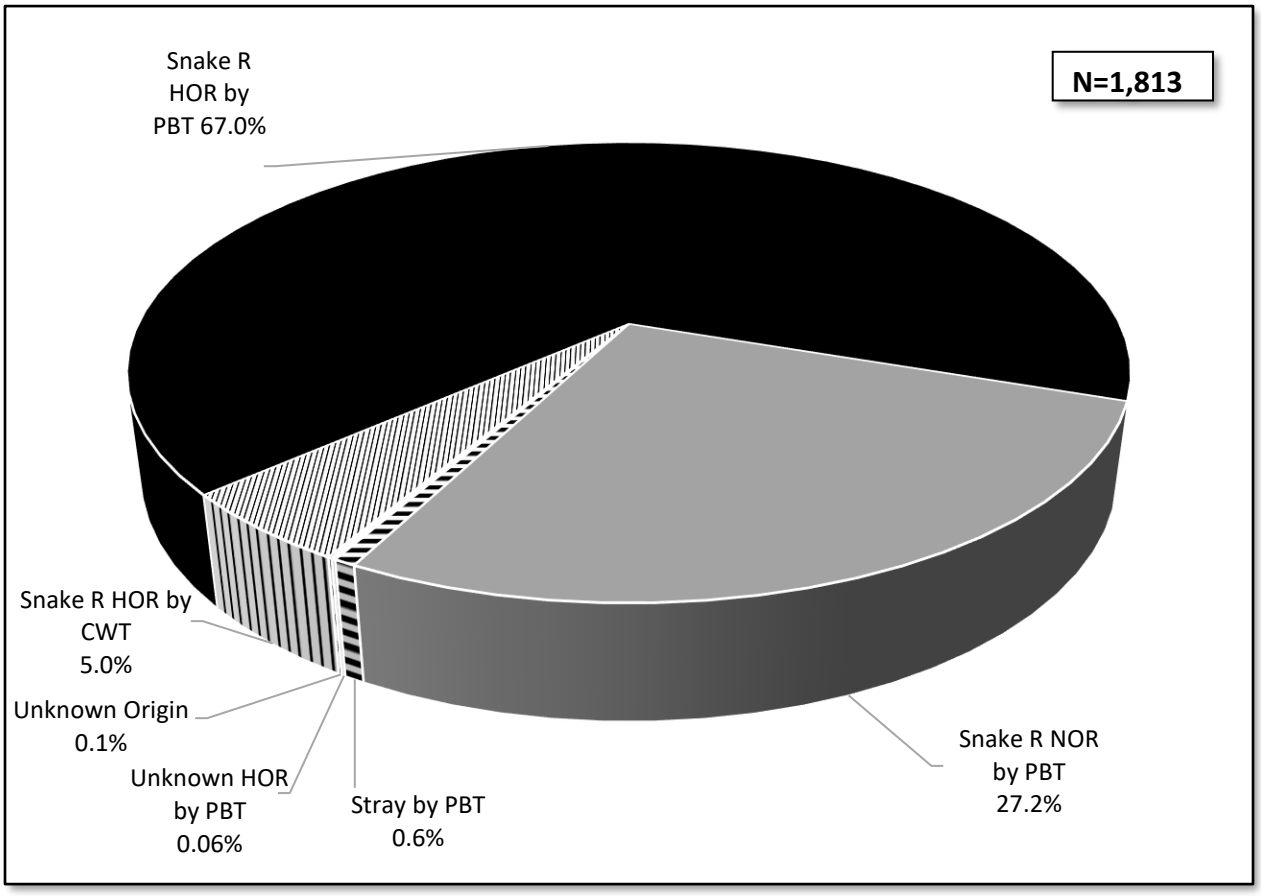

Figure 7. Percentages by fish origin with PBT results contributing to fall Chinook salmon broodstock at LFH during 2021.

A concentrated effort has occurred since 2010 to spawn older and larger sized males and females because of the large number of jacks and some jills that had been used in the past. Saltwater age composition of fish used as broodstock are summarized pre- and post-protocol change in 2010 (Figure 8). Length frequencies of SRFCH used for broodstock at LFH in 2021 are presented in Figure 9. Males used multiple times during spawning are captured in this figure. Unknown origin can include both HOR and NOR fish. Median length of fish used for broodstock

was 80 cm for females and 81 cm for males. In 2021, an estimated 3.2% of the males and 4.6% of the females were returns from yearling releases.

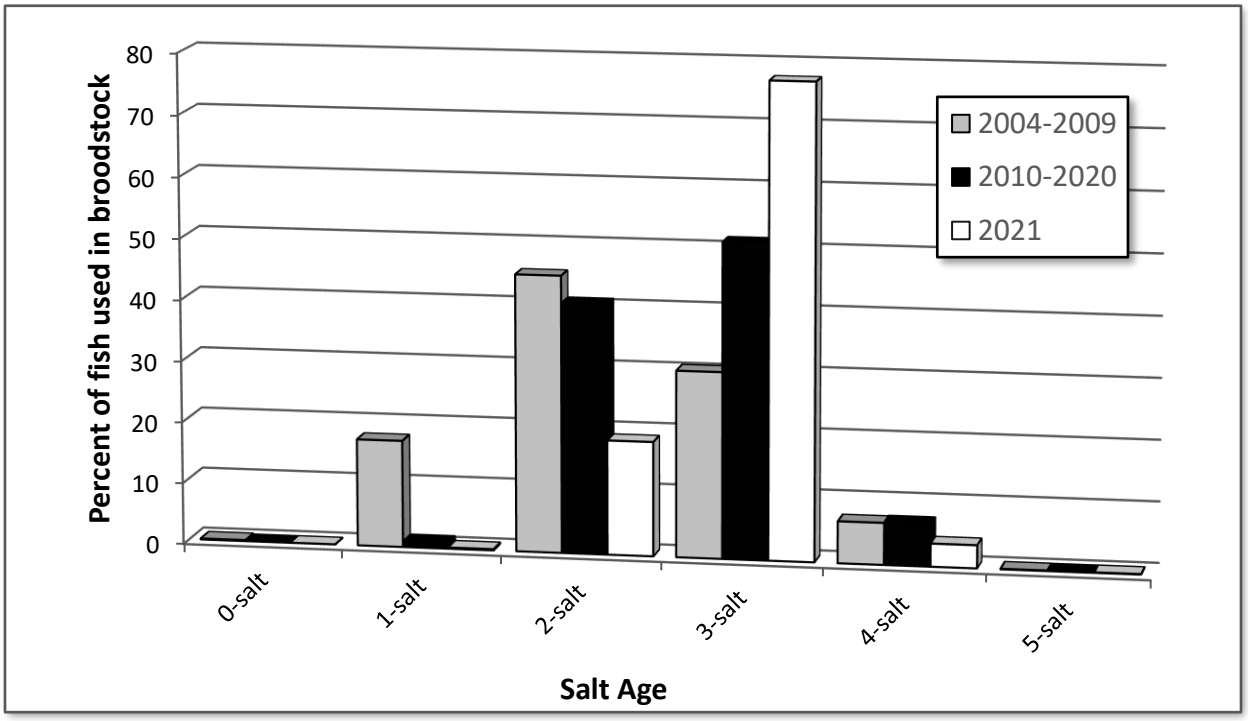

Figure 8. Percentages of salt ages of fall Chinook salmon spawned at LFH before and after changes in broodstock spawning protocols. Brood year 2021 is provided for specific reference.

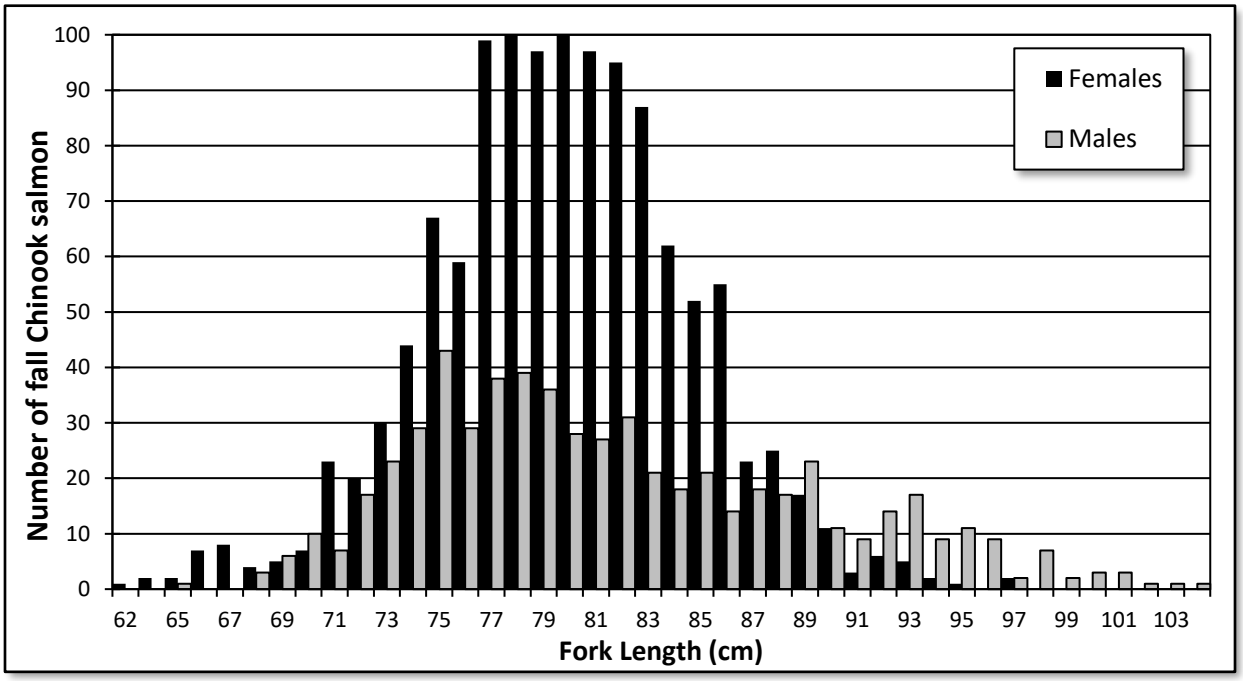

Figure 9. Fork lengths of fall Chinook salmon spawned as broodstock at LFH in 2021.

Males and Females Used in Broodstock

Origin was determined for both male and female fall Chinook contributing to production in 2021. Based on PBT, CWT, or PIT tag data 70.9% of the males spawned were determined to be Snake River HOR. Based on PBT 28.1% of the males were identified as Snake River NOR. An additional 0.34% of the males were identified as unknown HOR based on AD clip, lost/unreadable CWT tags, or yearling scale patterns, and 0.50% were identified as stray HOR based on PBT, PIT tag or CWT data. Another 0.17% were identified as unknown origin due to individuals failing to genotype, intact adipose and no CWT present. At the start of spawning, the goal was not to exceed four females per male; however, four males were used 5 times, seven males were used 6 times, one male was used 7 times and another male was used 8 times (Table 9). Like the males, based on PBT, CWT, or PIT tag data, 72.5% of the females spawned were Snake River HOR, with PBT determining that 26.8% of the females were Snake River NOR. Another 0.7% were determined to be stray HOR based on PBT, CWT, or PIT tag data (Table 9). An additional 0.08% of the females were identified as unknown origin due to individuals failing to genotype, intact adipose and no CWT present.

Table 9. Origin of males and females that contributed to production at LFH, 2021.

	Times each male was used for mating									
Origin determination method	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total unique**	**% Used**
Males										
Snake R Hatchery	105	222	78	5	4	7	1	1	**423**	**70.9%**
Snake R Natural	38	106	22	2					**168**	**28.1%**
Unknown Hatchery	1	1							**2**	**0.34%**
Stray Hatchery		3							**3**	**0.50%**
Unknown Origin		1							**1**	**0.17%**
Total unique males	**144**	**333**	**100**	**7**	**4**	**7**	**1**	**1**	**597**	
Females										
Snake R Hatchery	881								**881**	**72.5%**
Snake R Natural	326								**326**	**26.8%**
Unknown Hatchery	0								**0**	**0.0%**
Stray Hatchery	8								**8**	**0.7%**
Unknown Origin	1								**1**	**0.08%**
Total unique females	**1,216**								**1,216**	

Inclusion of NOR fish in broodstock

Inclusion of NOR unmarked/untagged fall Chinook salmon were incorporated into the broodstock beginning in 2002 (Figure 10). To estimate the proportion of natural origin brood (pNOB), a dataset was constructed to reflect all parents that had the potential to contribute to production, broken into size categories by mark/clip, and used the estimated NOR at LGR from

the run reconstruction method. Since 2016, a separate estimate of pNOB has been derived based on the fish spawned, including males that were used more than once, with origins determined from a combination of PBT, CWT and PIT tags. The pNOB estimates from spawning have generally been higher than what was predicted from the run reconstruction due to the multiple use of males, especially since we target the multiple use of unmarked/untagged (more likely to be NOR) males, which would in theory increase pNOB. In 2021, the estimated pNOB in the WDFW broodstock was 26.0% (Figure 10). The overall spawned hatchery pNOB for LFH and NPTH combined was 25.0% and was similar to the predicted pNOB by the run reconstruction method, 27.0%.

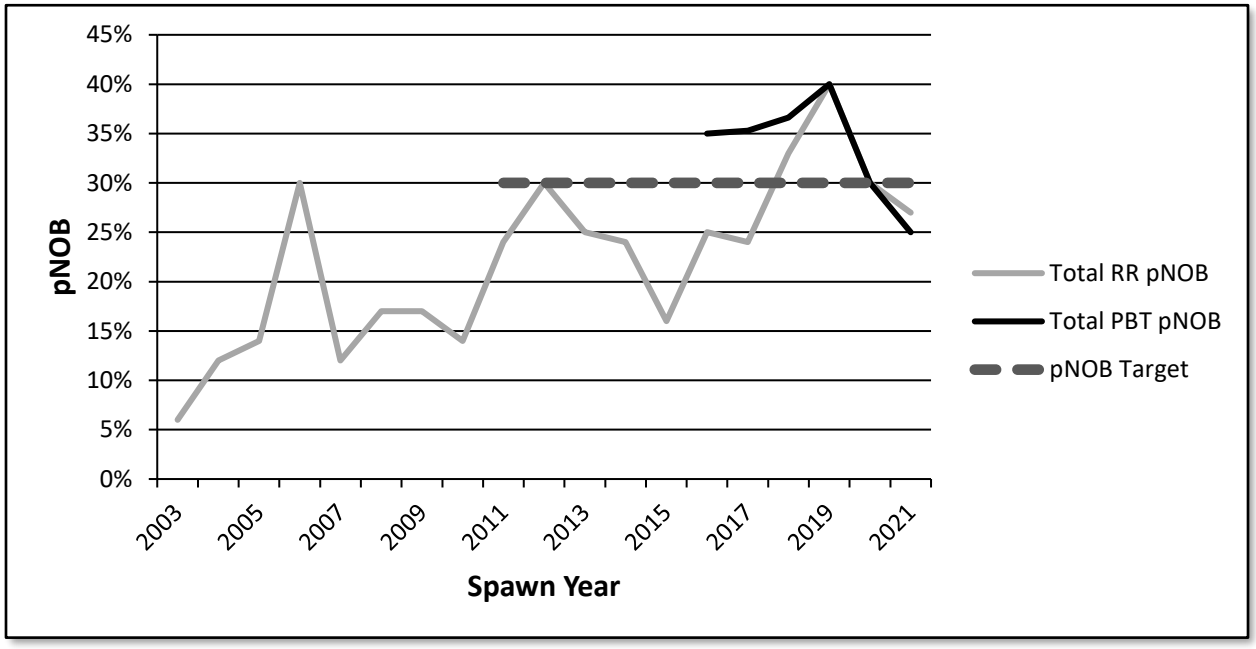

Figure 10. Estimated percent NOR parents in the broodstock (pNOB) at LFH and NPTH combined, based on the run reconstruction estimate or by PBT results from spawned fish at the hatchery, 2003-2021. The pNOB target for the program is 30%.

Jacks and Jills and Stray Fall Chinook Salmon in Broodstock

As described previously, WDFW has implemented a size selective collection and mating protocol, with one of the main goals to reduce the contribution/influence of mini-jacks, jacks, and jills in the broodstock. We calculated saltwater age for wire tagged fish by subtracting 1 from the total age of subyearlings and 2 from the total age of yearlings. This method has the potential to overestimate saltwater ages for subyearlings since reservoir rearing is not taken into consideration. Untagged fish are scale sampled and reservoir rearing is used to estimate the correct salt-water age. Jacks and jills in broodstock should be considered minimum estimates because of the above explanation of potential biases in our estimates created by

reservoir reared fish. Intensive monitoring of jacks and jills in the broodstock began in 2010 to minimize their overall contribution. This monitoring and subsequent management action has reduced the total matings with 0 and/or 1-salt parentage by 97% over the last 12 years (Appendix D).

The WDFW goal is to fully exclude strays from broodstock to maintain the genetic integrity of the SRFCH salmon that LFH produces. In cases where we are broodstock limited, it was agreed that strays may be included up to 5% of the spawners. To assure productions goals were met as mandated in the 2018-2027 *United States v. Oregon* Management Agreement, eight females and three males were determined to be strays either by CWT or PBT assignment. All of these were spawned and the gametes were retained until the end of the spawning season. Due to high egg loss (see Hatchery Operations section above, and juvenile outmigration below), all viable gametes from strays were kept as part of the program to fulfill production goals. Total estimated production from stray crosses was 0.6% of the total production. Strays retained as broodstock over the years are presented in Appendix D. Males used multiple times are included multiple times in Appendix D.

Juvenile Rearing and Marking and Tagging

Information regarding eggs taken, egg loss, eggs culled, eggs shipped or retained, and numbers of fish ponded are included in Table 10. Historical egg take and ponding information is listed in Appendix E. Rearing followed standard hatchery procedures as described in the SRFCH salmon HGMP available at the LSRCP website. Further detailed information regarding type and size of vessels used for rearing SRFCH can be found in LFH Annual Reports available at the LSRCP website. https://fws.gov/office/lower-snake-river-compensation-plan

Marking and tagging of fish was consistent with the 2018- 2027 *US v. Oregon* Management Agreement. The LFH yearling (BY20) fish were 100% ADCWT marked/tagged in the early summer of 2021. Staff performed tag and fin clip quality control checks from a sample prior to release from cast-netting fish from the rearing lake (Table 11). A portion of the subyearling (BY21) were ADCWT marked/tagged in the spring of 2022. All on-station release subyearlings (marked/tagged and unmarked/untagged) were diverted to the rearing lake after the yearlings were released in late March. Due to the high egg loss (see Hatchery Operation section above), there was no GRR (BY21) group released. Typically, the GRR fish would be ADCWT marked/tagged in the spring at Irrigon Fish Hatchery.

Table 10. Eggs taken and survival numbers by life stage of fall Chinook salmon spawned at LFH, brood years 2015-2021.

Brood year	Eggs taken	Egg loss	Eggs culled [a]	Eggs shipped	Eyed eggs retained	Fry ponded	Intended program
2015	4,569,472	127,974	132,098	1,540,000	2,769,400	930,000	Yearling
						1,839,400	Subyearling
2016	4,951,188	121,359	61,346	1,540,000	3,228,483	1,008,647	Yearling
						1,995,000	Subyearling
2017	4,685,575	212,043	48,940	1,541,282	2,883,310	930,000	Yearling
						1,912,017	Subyearling
2018 [b]	4,754,622	158,706	18,863	1,315,510	3,261,543	484,356	Yearling
						2,761,054	Subyearling
2019	4,687,449	143,141	23,489	1,332,784	3,171,230	614,284	Yearling
						2,704,713	Subyearling
2020	4,603,680	141,273	58,258	1,311,219	4,515,433	467,822	Yearling
						2,521,837	Subyearling
2021	4,704,700	1,193,437	0	0	4,989,169	469,700	Yearling
						2,923,404	Subyearling

[a] Eggs culled due to ELISA results, stray, jill or jack matings.

[b] The decrease in yearling production, and increase in subyearling production, reflects the new 2018-2027 US v. Oregon Management Agreement

Table 11. Numbers of fall Chinook salmon sampled by WDFW for marking and tagging quality control checks.

Brood Year	Group	Release site	Mark type	CWT	Number sampled	AD/ CWT	AD clipped only	CWT only	Unmarked/ untagged
2020	Yearling	LFH	ADCWT	637944	1833	1816 (99.07%)	1 (0.06%)	2 (0.11%)	14 (0.76%)
2021	Subyearling	LFH	ADCWT	638056	2,302	2,286 (99.3%)	4 (0.17%)	12 (0.52%)	0 (0.00%)
2021	Subyearling	GRR [a]	ADCWT	NA	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

[a] No releases occurred in the Grande Ronde in 2022 due to the high egg loss in the 2021 brood.

In Hatchery Survival Rates to Release

The estimated number of eggs and fish present at life stages in the hatchery were used for 2015-2021 release years to calculate survival rates within the hatchery environment (Table 12). The original survival goal for the program was 80% [(9,160,000 subyearling juveniles/11,450,000 eggs) x 100] from USACE 1975. Prior to 2021, the survival goal had been achieved each year for yearlings since 2003 and each year for subyearlings since 1990. However, given the high egg loss in 2021, overall survival from green egg to fry ponded or smolts released was the lowest on record (Table 12).

Table 12. Estimated survivals (%) between various life stages at LFH for fall Chinook salmon, 2014-2021 subyearling and yearling brood years.

Brood year	Subyearling Green egg-ponded fry %	Yearling Green egg-ponded fry %	Subyearling Ponded fry-release [a] %	Yearling Ponded fry-release [a] %	Subyearling Green egg-release %	Yearling Green egg-release %
2014	95.2	95.2	98.5	97.1	93.8	92.5
2015	94.6	94.6	99.5	100.1	94.2	94.7
2016	94.9	94.9	94.2	87.3	94.2	82.8
2017	92.2	92.2	96.7	95.4	89.2	88.0
2018	94.4	95.3	98.9	91.9	93.3	86.7
2019	95.2	95.2	100.0	86.9	82.7	82.7
2020	95.0	95..0	99.9	86.0	94.0	82.0
2021	76.0	NA	75.1	NA	56.9	NA
Mean	**92.2**	**94.6**	**96.0**	**91.5**	**89.1**	86.5
SD	**6.7**	**1.1**	**8.5**	6.4	**13.2**	5.6

[a] Survival estimates occasionally exceed 100% due to inventory tracking methodologies used at LFH.

Fish Health Sampling

Fish health sampling at LFH on SRFCH occurs occasionally or as needed. In the last few years, and for BY20 yearlings or BY21 subyearlings, no disease issues occurred. Currently, pre-transfer fish health sampling is required for all FCAP program fish since we are transferring them to another agency and across state boundaries. For the on-station releases at LFH, no pre-liberation fish health sampling occurs. However, WDFW plans on re-initiating pre-liberation fish health sampling for all transfer/release groups (and all species at LFH) in the near future.

Juvenile Releases

Yearling fall Chinook salmon were released at LFH from 22-23 March 2022 (Table 13). At the time of release, a sample of fish were measured and weighed (n=305). Per NOAA Permitting, staff also look for and record any signs of sexual precocity; none were observed. Staff also looked for, but didn't visually observe any signs of BKD, pop-eye, or descaling in this group. An estimated total of 433,895 were released, with approximately 429,871 that were ADCWT, 237 were adipose only, an additional 473 were CWT only due to tagging error, and 3,314 were released as unmarked/untagged. Size at release was estimated at 10.0 fish/lb (fpp). Releases in 2022 were again earlier than in previous years, and well before any increasing hydrograph in the Snake River. Historical yearling and subyearling releases from 2010 to 2022 by WDFW, IPC and NPT are available upon request to WDFW. All WDFW fall Chinook releases from 2022 are provided in Appendix F.

Subyearling fall Chinook salmon at LFH were released 24-25 May 2022. On the first day of release, a subsample of fish (n=205) were measured and weighed (Table 13). Per NOAA

permitting, staff also look for and record any signs of sexual precocity; none were observed. Staff also looked for, but didn't visually observe any signs of BKD, pop-eye, or descaling in this group. An estimated total of 517,161 were released, with 203,311 as an ADCWT group, 1,067 CWT only, 356 adipose fin clip only, and 312,427 were released as unmarked untagged. Size at release was estimated at 46.1 fpp. The release occurred during a slightly increasing hydrograph in the Snake River.

Due to egg loss during spawning in 2021, there were no subyearling fall Chinook reared at Irrigon Fish Hatchery in 2022 for the GRR release group.

Table 13. Length and weight data from fall Chinook salmon released at LFH or in the GRR in 2022.

Length/weight data	Yearling Snake R at LFH	Subyearling Snake R at LFH	Subyearling GRR at Cougar Creek
Sample date(s)	21 March	23 May	NA
CWT code	637944	638056	NA
Number sampled	305	205	NA
Avg. length (mm)	165	96	NA
Median length	164	95	NA
Range of lengths	124-207	77-113	NA
SD of lengths	15.7	5.8	NA
CV of length (%)	5.9	6.1	NA
Avg. weight (g)	46.8	9.8	NA
SD of weight	14.9	2.1	NA
Avg. K factor	1.08	1.11	NA
FPP [a]	9.1	46.1	NA
Precocious (%)	0.0%	0.0%	NA

[a] The fish/lb sample shown here for the yearlings differs from what is reported by hatchery staff as a final number. Throughout each release at LFH, multiple pound count samples are taken by hatchery staff and are likely more accurate than the single sample taken by evaluation staff. However, the subyearling sample by Evaluation staff, and that from LFH hatchery staff were the same.

PIT Tagging, Migration Timing, Travel Speed and Survival

Staff have routinely PIT tagged a subset of the LFH yearling and subyearling releases, and the GRR releases for the purpose of either monitoring outmigration timing, estimating adult returns in-season, and to estimate a conversion rate between IHR and LGR for purpose of back-calculating the run reconstruction estimates to the project area (see section below on returns to the project area). PIT tag lists for each release group are submitted to PTAGIS and all fish were assigned to monitor mode to allow them to be treated like non-PIT tagged fish when intercepted at the mainstem dams, thereby representing the entire release group during out-migration.

Staff PIT tagged 10,000 BY20 yearlings on 21 March and 15,000 BY21 subyearlings on 23 May. Tagged fish were held for one day in the release structure raceway following tagging, and then released directly to the Snake River. Before fish were released the following day, mortalities were collected and scanned for PIT tags. The holding raceway was then immediately scanned for shed tags after the PIT tagged fish were released to the river. Any tags from mortalities, or shed tags recovered were re-inserted into new fish and released the same day. As previously mentioned, due to the high egg loss, there was not a release group for Grand Ronde release group. However, SRL assisted IPC staff at Irrigon Fish Hatchery by PIT tagging 4,500 BY21 subyearlings in late April 2021 for the IPC release in the Salmon River. The PTAGIS website (www.ptagis.org) was queried on 12 December 2022 for the two LFH on-station releases in 2022. Interrogation summaries were used to populate Tables 14 and 15.

Table 14. Migration timing of PIT tagged yearling fall Chinook released at LFH in 2022. Dam abbreviations are as follows: LMO – Lower Monumental, IHR – Ice Harbor, MCN – McNary, JDD – John Day, and BONN – Bonneville.

Yearlings released at LFH	LMO	IHR	MCN	JDD	BONN [a]
Number Detected	**1,214**	**724**	**316**	**316**	**259**
Median Travel Days from LFH [b]	9.2	11.9	26.1	30.8	42.9
Median Passage Date	3/31	4/2	4/17	4/21	5/3
First Detection Date	3/24	3/27	3/29	3/31	4/7
Last Detection Date	5/2	5/14	5/19	5/29	5/28
10% of Run Passage Date	3/27	3/30	4/5	4/7	4/21
90% of Run Passage Date	4/18	4/18	4/27	5/9	5/4
TDG on Median Date (%)[c]	103	102	104	111	112
Average Discharge on Median Date of Passage (kcfs)[c]	45	52	133	160	215
Spill on Median Date (kcfs)[c]	NA	0.1	73.9	77.3	116.8

[a] TDG, outflow and spill for BONN are detected six miles downstream at Warrendale.
[b] Travel days are calculated from the date of release.
[c] Detections are from the tailrace of each dam.

Table 15. Migration timing of PIT tagged subyearling fall Chinook released at LFH in 2022. Dam abbreviations are as follows: LMO – Lower Monumental, IHR – Ice Harbor, MCN – McNary, JDD – John Day, and BONN – Bonneville.

Subyearlings released at LFH	LMO	ICH	MCN	JDD	BONN [a]
Number Detected	**1,068**	**732**	**706**	**658**	**391**
Median Travel Days from LFH [b]	7.6	13.1	18.4	17.3	16.3
Median Passage Date	5/31	6/6	6/11	6/10	6/9
First Detection Date	5/26	5/27	5/29	10/1	6/2
Last Detection Date	7/6	7/4	7/3	7/9	7/8
10% of Run Passage Date	5/27	5/30	6/5	6/5	6/4
90% of Run Passage Date	6/11	5/30	6/16	6/19	6/8
TDG on Median Date of Passage (%)[c]	123	122	117	121	124
Avg Discharge on Median Date of Passage (kcfs)[c]	63	82	222	209	225
Spill on Median Date of Passage (kcfs)[c]	78.2	115.9	266.6	198.9	213.9

[a] TDG, outflow and spill for BONN are detected six miles downstream at Warrendale.
[b] Travel days are calculated from the date of release.
[c] Detections are from the tailrace of each dam.

The on-station (both yearling and subyearling) and GRR subyearling releases have been PIT tagged for several years. In the following section we provide estimated survival and migration speed to the first dam of encounter (LGR or Lower Monumental), and the first and last dam of encounter on the Columbia River (McNary and Bonneville), respectively (Figures 11-16). For most years provided below, downstream survival estimates for all groups were derived using DART (http://www.cbr.washington.edu/dart), but occasionally those estimates were not valid. In such instances, the PITPRO program was used to generate estimates. PITPRO incorporates mortalities and recaptures into the estimated calculation, and occasionally will provide a valid survival estimate where DART doesn't. Comparison of survival estimates from these two programs when both available are generally within a percent or two.

While no releases occurred in the GRR in 2022, we still provide migration survival and travel speed from previous years. Survival to LGR from the GRR releases average about 75% but have varied widely over time from 45% to 100% (Figure 11). Migration speed to LGR has also decreased in the last few years and may explain the slightly lower survival to LGR (Figure 12).

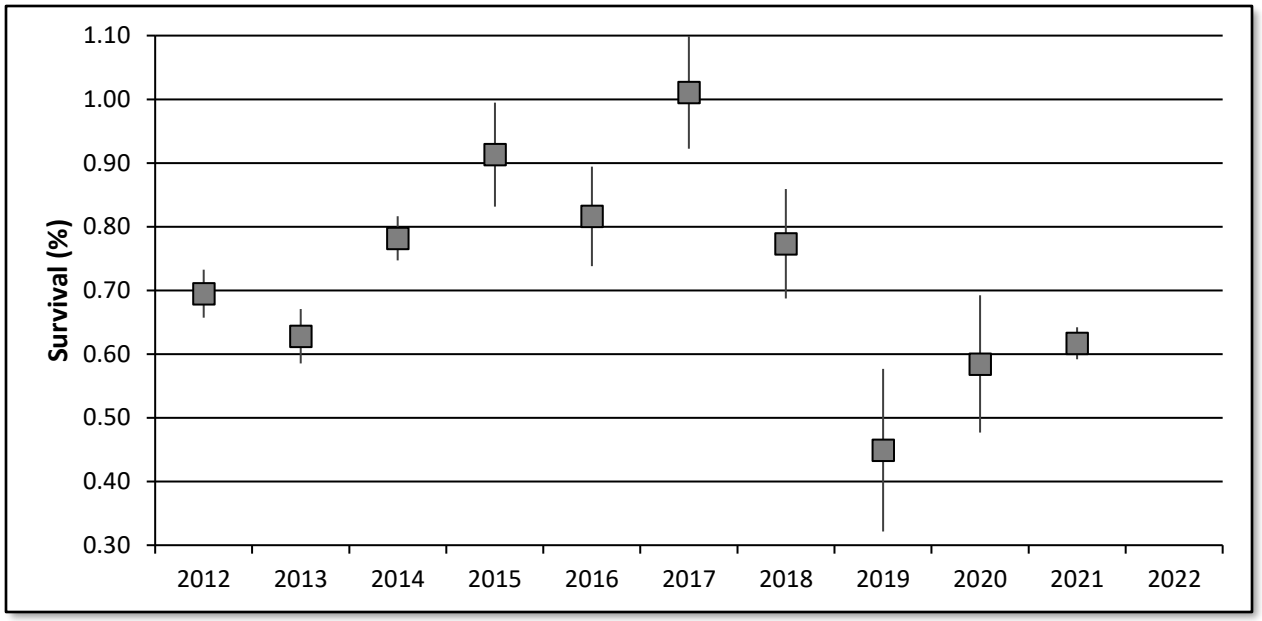

Figure 11. Survival and standard error of SRFCH subyearlings released into the Grande Ronde River near Cougar Creek to LGR, 2012-2022 migration years. Due to egg loss for BY21, there is no release group for 2022.

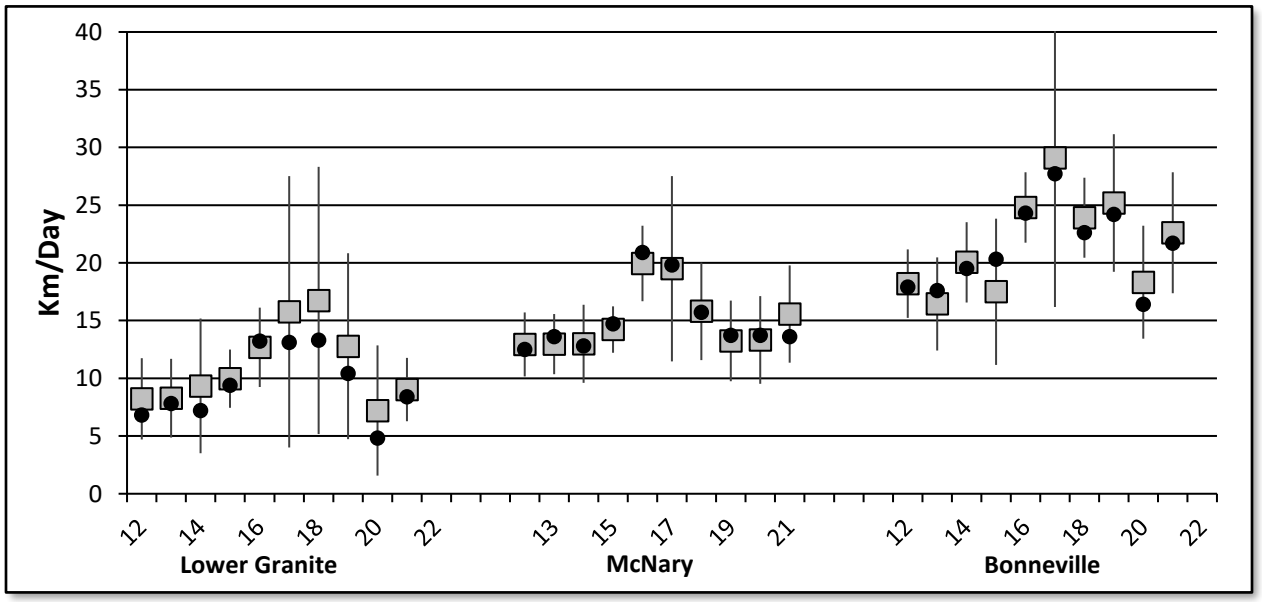

Figure 12. Average travel speed (Km/day with S.D.) and median travel speed (black dot) of SRFCH subyearlings released into the Grande Ronde River near Cougar Creek to LGR, McNary, and Bonneville Dams, 2012-2022 migration years. Due to egg loss in BY21 there is no release group for release year 2022.

Survival of the on-station subyearling release to Lower Monumental Dam has declined in recent years (Figure 13). Migration speed has also decreased in the last few years and may explain the slightly lower survival to Lower Monumental Dam (Figure 14).

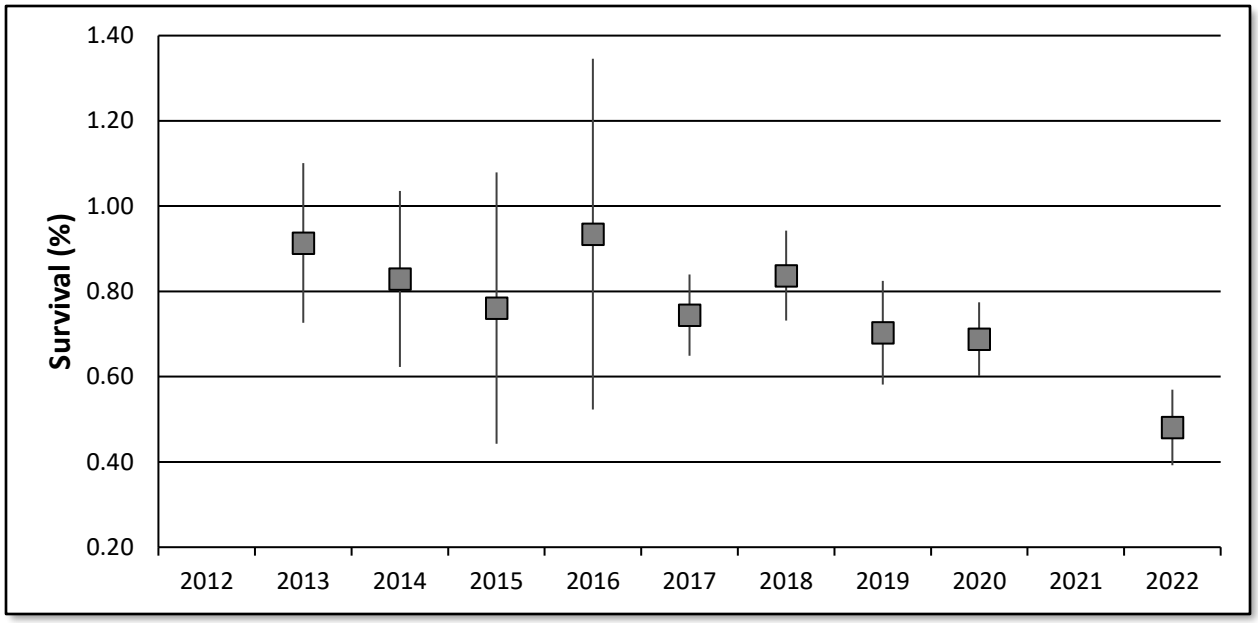

Figure 13. Survival and standard error of SRFCH subyearlings released into the Snake River at LFH to Lower Monumental Dam, 2013-2022 migration years. Note: 2012 and 2021 estimates from DART were not valid, hence PITPRO was used for those years.

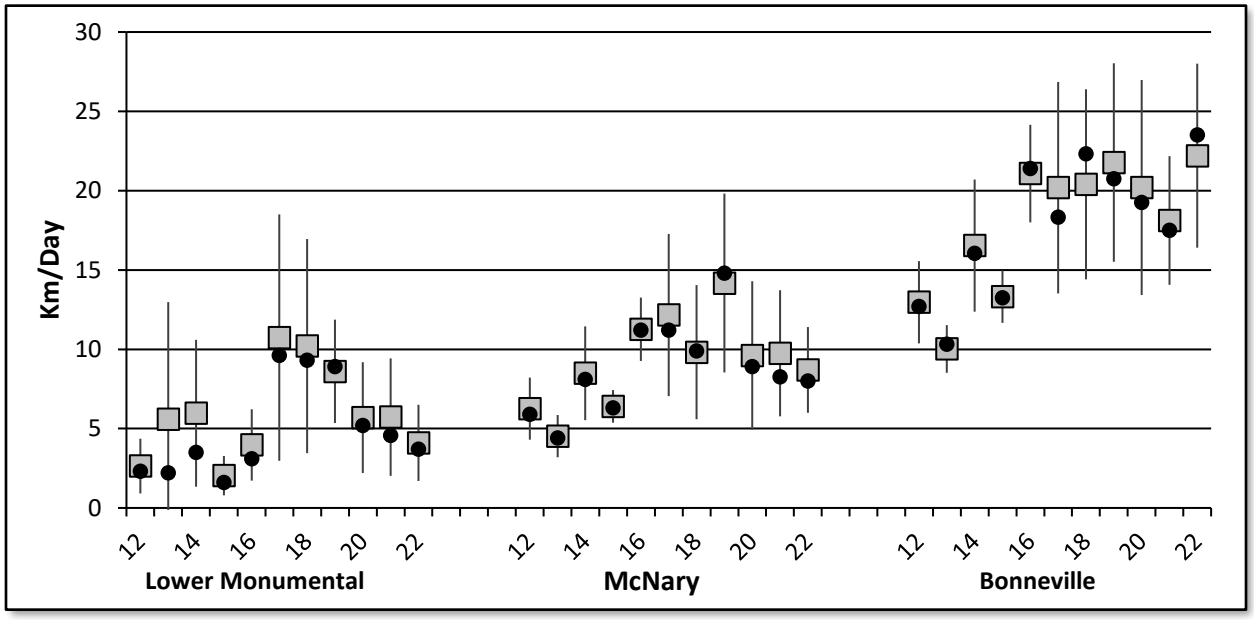

Figure 14. Average travel speed (km/day with S.E.) and median travel speed (black dot) of SRFCH subyearlings released into the Snake River at LFH to Lower Monumental, McNary, and Bonneville Dams, 2012-2022 migration years.

Survival of the on-station yearling release to Lower Monumental Dam was generally around 90% until recently (Figure 15). Yearling migration speed had generally remained constant over the years except the last four migration years (Figure 16). Yearlings are released about 1.5 months earlier in the spring compared to the subyearling releases and flows and spill are

usually lower than later spring months. Survival and travel speeds for the last four years for released yearlings were the lowest for the years reported and are likely as result of these fish being released in mid-March compared to their previous normal release time during the first or second week or April.

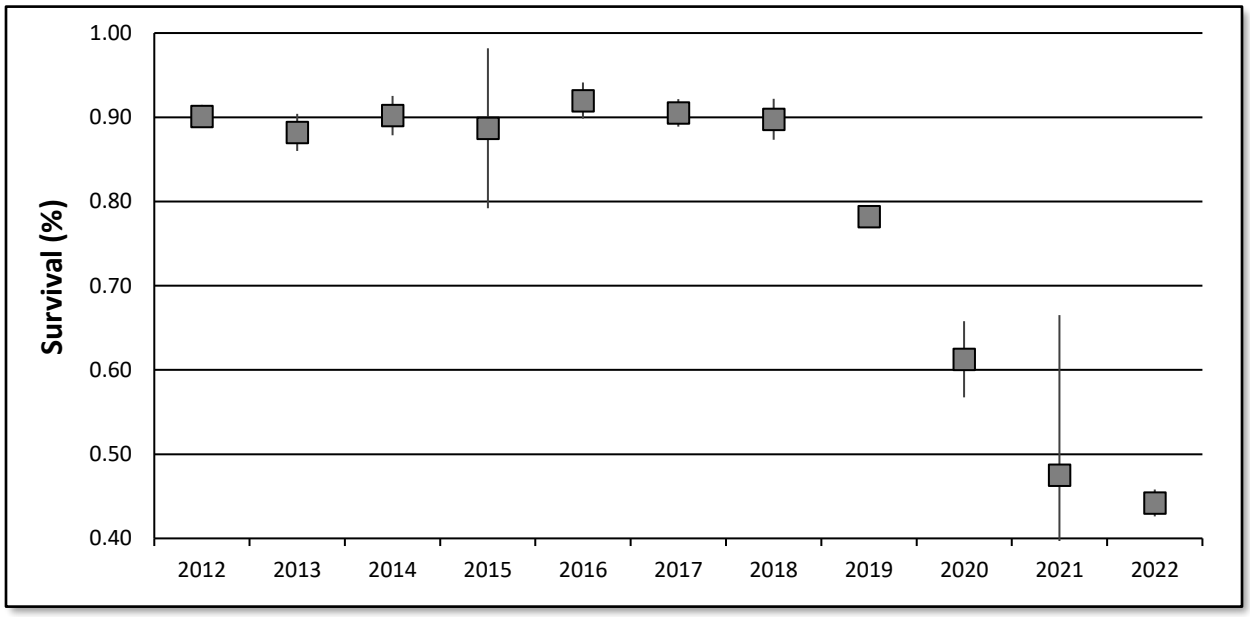

Figure 15. Survival and standard error of SRFCH yearlings released into the Snake River at LFH to Lower Monumental Dam, 2012-2022.

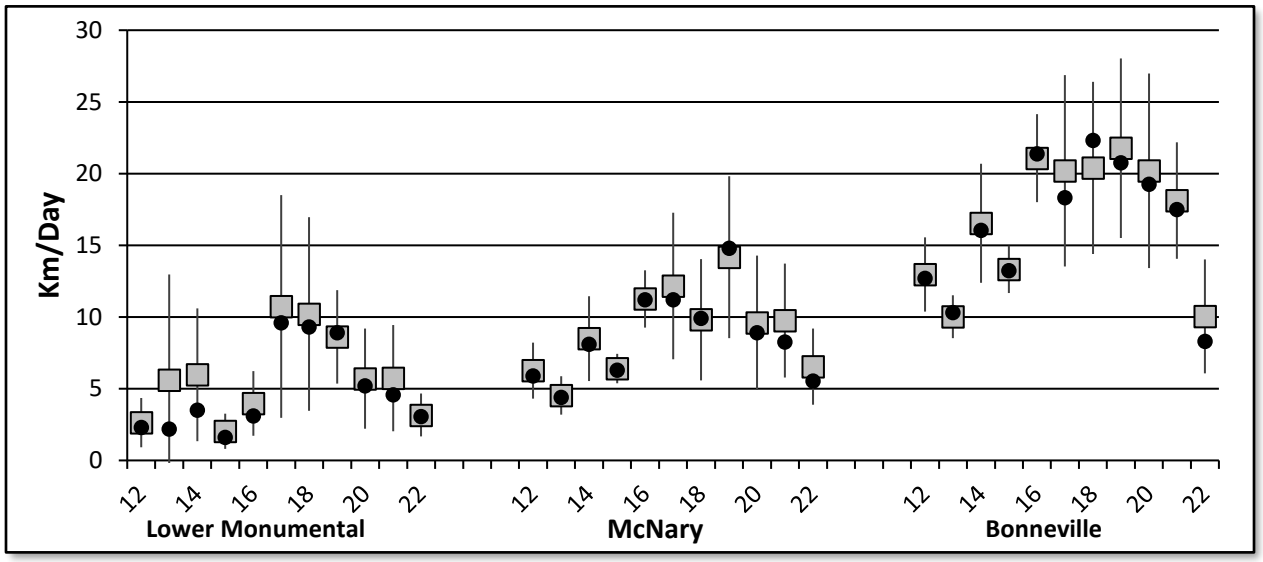

Figure 16. Average travel speed (km/day with S.E.) and median travel speed (black dot) of SRFCH yearlings released into the Snake River at LFH to Lower Monumental, McNary, and Bonneville Dams, 2012-2022 migration years.

The reason why the yearling release date was moved forward was a direct result of changes that were made to the SRFCH program during the re-negotiation of the 2018-2027 *US v Oregon* agreement. With an increase to the subyearling on-station release (200K to 700K), staff could utilize one of the large rearing lakes for the final 1.5-2 months of subyearling rearing – which we hypothesized would benefit their post-release survival. To take advantage of that, it was decided to advance the release time of yearlings by about two weeks. While reported survival to Lower Monumental Dam has dropped off considerably in the last four years, it's unclear if these estimates are completely valid. Since yearling fall Chinook are released generally 2-3 weeks prior to when the extended bypass screens are set in place at the dams, survival estimates are likely being biased low because many fish are passing the dams without being detected in the bypass facilities. Given that possibility, survival estimates to other downstream locations were also generated using DART to see if releasing this group of fish earlier has potentially had a negative effect on overall survival. Based on estimates to locations downstream, it does appear that the last four years releases may be somewhat lower than previous, but not to the extent as indicated by the survivals to Lower Monumental Dam (Figure 17). For 2022, WDFW has decided to move the yearling release back to March 31, which lines up to when historical releases occurred.

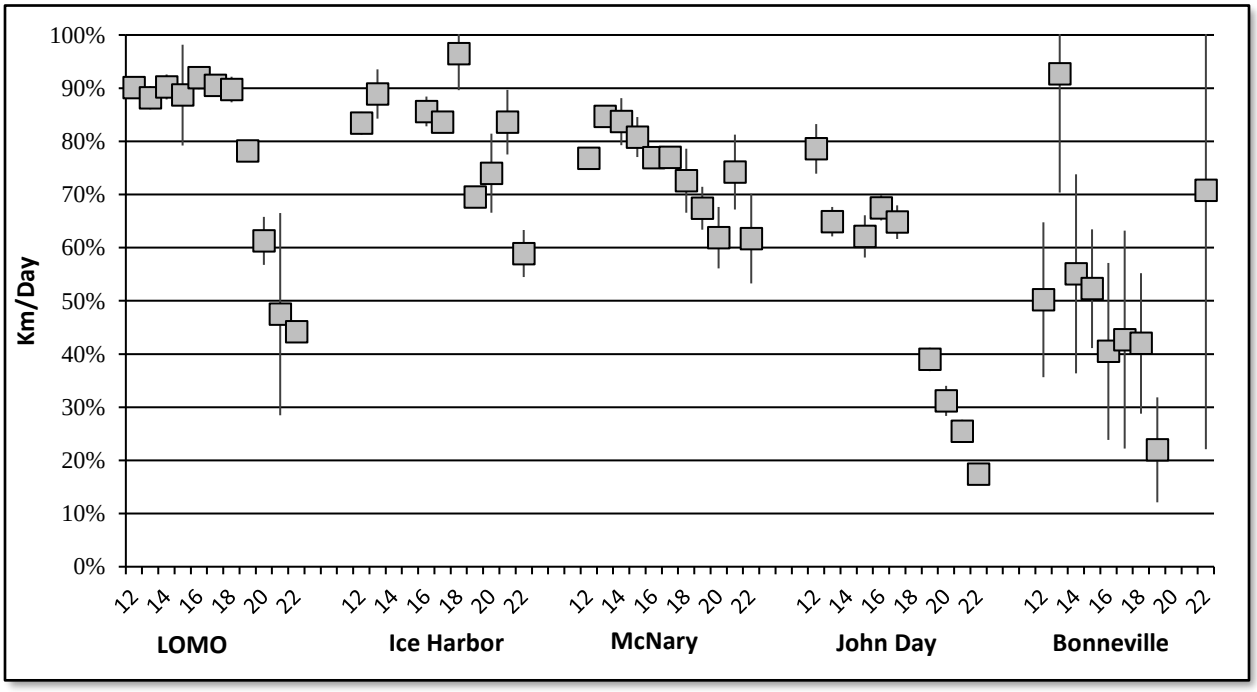

Figure 17. Survival and standard error of SRFCH yearlings released into the Snake River at LFH to Lower Monumental Dam (LOMO), Ice Harbor, McNary, John Day, and Bonneville Dams, 2012-2022 migration years.

Tucannon River Natural Production 2021

Spawning Ground Surveys

WDFW personnel have conducted spawning ground surveys for fall Chinook salmon on the lower Tucannon River since 1985 (Appendix H). Survey sections in 2021 covered the river from river kilometer (rkm) 1.1-22.4. The first 1.1 rkms of the Tucannon River are deep slack water from Lower Monumental Dam reservoir and no surveys or estimates are made for that area. Because of the slow, deep river flow in that area, spawning is considered minimal. During 2021, landowner access restrictions prevented the surveying of 1.6 rkms a little below and above the Starbuck Bridge within survey sections 5 and 6 (Appendix H). Regular weekly surveys began the week of 18 October and continued until the week of 6 December.

A total of 369 redds (combination of fall Chinook and Coho) were counted in the surveyed areas of the Tucannon River (Table 16) and we estimate an additional 21 redds occurred in sections not surveyed. An estimated total of 390 total redds (240 fall Chinook salmon and 150 coho salmon redds) were constructed in the Tucannon River during 2021.

Table 16. Date and number of salmon redds and carcasses counted on the Tucannon River in 2021.

Week beginning	Total redds [a] Chinook & Coho [b]	Carcasses sampled Chinook	Coho
Prespawn survey 18 Oct	13	2	4
25 Oct	36	0	1
1 Nov	88	4	18
8 Nov	15	19	14
15 Nov	102	52	26
22 Nov	40	23	9
29 Dec	41	55	15
6 Dec	34	3	1
Totals	**369**	**158**	**88**

[a] Observed redds not expanded for sections with access restrictions, or not surveyed at all.

[b] Chinook & coho salmon redd data estimated through visual counts were combined.

Escapement and Composition of the Fall Chinook Salmon Run in the Tucannon River

Previously, the estimated number of fall Chinook redds to the Tucannon River was based on the composition of redds (Chinook or coho) estimated by; 1) surveyor assignment of what species made a particular redd, or 2) from the proportions of carcasses recovered for the season. However, a standard method wasn't adopted. In 2020, evaluation staff began comparing three different methods to determine the most consistent way to provide an estimate of fall Chinook

and coho for the future. These three methods are: 1) based on the proportion of fall Chinook and coho at the Lower Monumental Dam window counts and applied to the total number of redds, 2) based on individual redd determination from surveyors, and 3) based on the proportion of Chinook and coho carcass recovered. Fall Chinook and coho overlap in spawn time, and determining if a redd is a fall Chinook or coho can be incredibly difficult as most coho and 2-salt subyearling fall Chinook return at relatively the same size; hence redd sizes can be identical. Further, high flow events also cause issues, especially when gravel scouring occurs or when water clarity is affected. These conditions make it difficult to identify new versus old redds, or clearly seeing redds for identification purposes. The percent carcass recovery method can be biased by high water events, lack of carcasses due to predation or observers missing them, and misidentification. After our comparison, we believe utilizing the Lower Monumental Dams counts applied to total number of redds as the most accurate and consistent representation. Surprisingly, the annual difference between the three estimation methods are minimal (Figure 18). Table 17 has been updated from previous reports to show the updated redds, escapement (3 fish/redd), and juvenile productivity in the Tucannon River based on the Lower Monumental Dam counts.

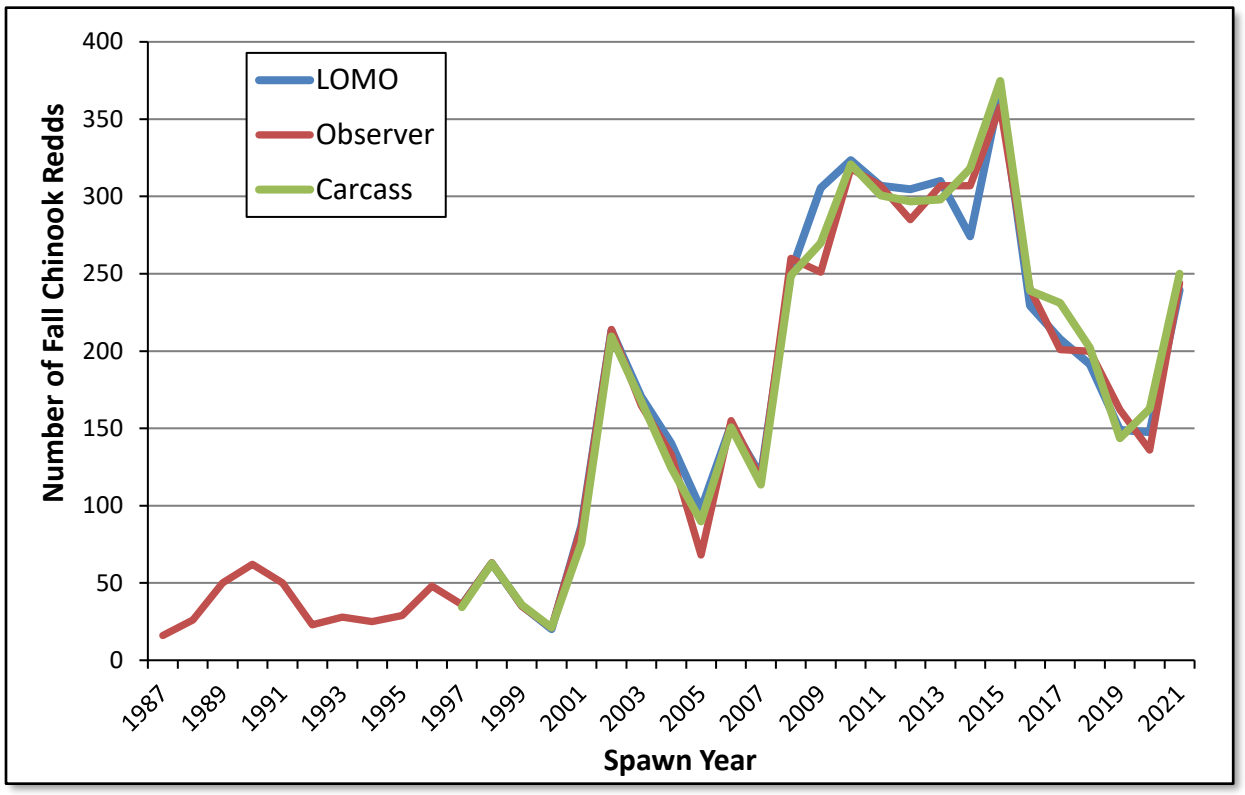

Figure 18. Estimated fall Chinook salmon redds in the Tucannon River based on three estimation techniques. The LOMO method uses the proportion of fall Chinook to coho at Lower Monumental Dam, the Observer methods uses "redd origin" as determined by surveyors, and the Carcass method relies on the proportion of fall Chinook to coho carcasses recovered from surveys.

Total escapement to the Tucannon River is based on an expansion factor of three fish/redd. We believe this expansion factor provides a conservative estimate of fish spawning. Based on the Lower Monumental Dam proportion method we estimated 719 fall Chinook salmon spawned in the Tucannon River in 2021 (Table 17). Staff recovered 158 fall Chinook salmon carcasses (~22%) of the estimated total spawning escapement. A total of 449 coho salmon were estimated to have spawned, of which 88 carcasses (~18%) were recovered in 2021. The run of fall Chinook salmon into the Tucannon is highly correlated with the overall fall Chinook run into the Snake River Basin (Figure 19).

Table 17. Estimated escapement, redd construction, and resulting estimates of smolts/redd and total number of emigrants from fall Chinook salmon spawning in the Tucannon River, 2001-2021, based on Lower Monumental Dam proportion method of redd origin. [a]

Brood year	Estimated escapement [b]	# Redds observed	# Redds in no access areas and other adj (est.)	Total # of redds (est.)	Estimated smolts/redd [c]	Total # estimated emigrants [d]
2001	261	65	12	87	271	23,577
2002	640	185	29	213	92	19,582
2003	511	143	22	170	421	71,693
2004	421	126	8	140	500	70,070
2005	293	61	7	98	215	20,995
2006	457	128	27	152	293	44,563
2007	359	103	15	120	Unknown [f]	Unknown [f]
2008	753	223	46	251	19	4,834
2009	917	200	29	306	121	36,956
2010	971	290	29	324	76	24,659
2011	921	280	27	307	66	20,199
2012	914	256	28	305	394	120,033
2013	930	287	20	310	31	9,458
2014	822	270	37	274	569	156,073
2015	1,103	324	34	368	127	46,702
2016	688	218	22	229	35	7,945
2017	623	177	254	208	102	21,094
2018	574	172	28	191	230	43,972
2019	447	140	21	149	11	1,666
2020	443	119	17	148	522	77,046
2021	719	231	13	240	178	42,657

[a] Numbers presented in this table are different from prior reports and represent the most accurate estimates of escapement and production in the Tucannon to date.
[b] Estimates were derived using three fish per redd; no adjustments were made for super imposition of redds.
[c] Estimate was derived using total redds estimated above the smolt trap and the estimated emigration the following spring as measured at the smolt trap.
[d] Estimate was derived using the smolt/redd estimate and applying it to the total number of redds in the Tucannon River.
[f] No estimate was made because the smolt trap sampling box had a hole in it and fish escaped.

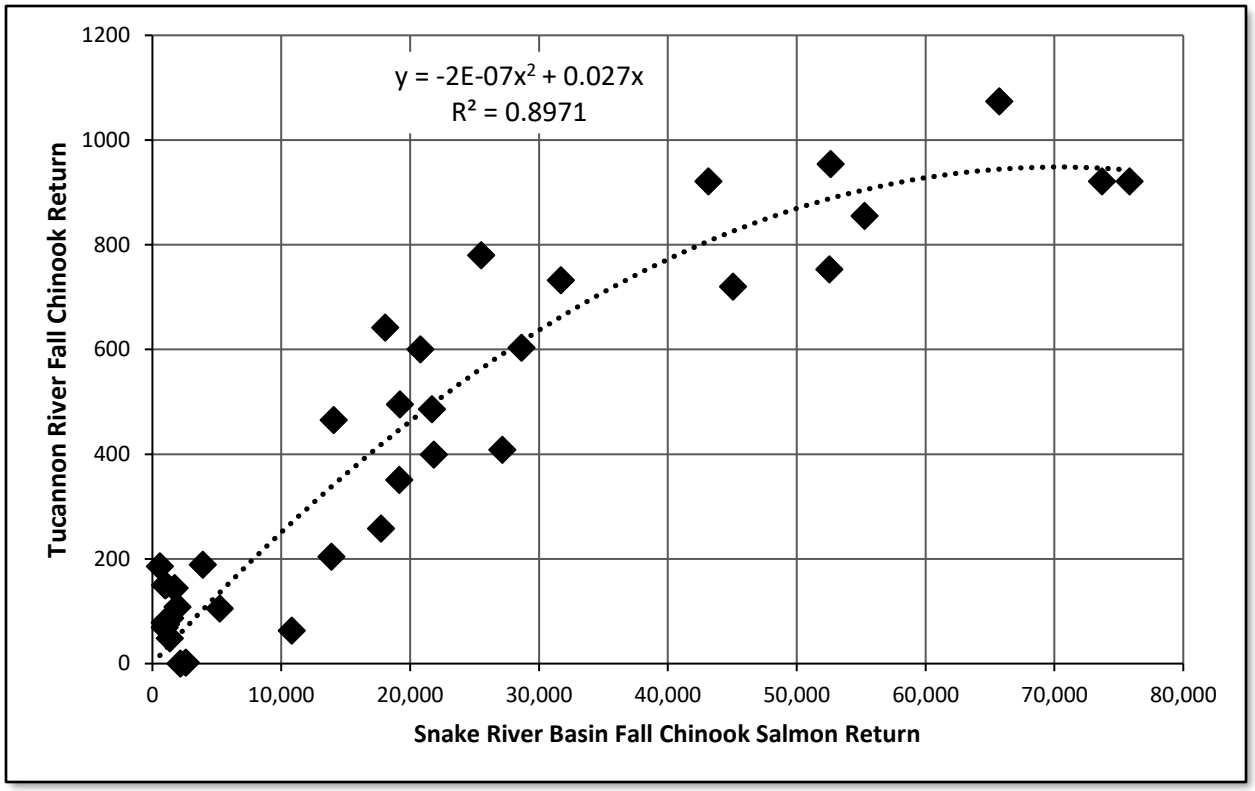

Figure 19. Relationship of the overall SRFCH return compared to estimated returns to the Tucannon River.

Generally, more recoveries of females occur than males, primarily because females remain in the vicinity of their redds when they die. In 2021 females represented 51.6% of the recoveries in the Tucannon River: primarily 2-salt and 3-salt fish. Males represented 45.9% of the recoveries; primarily 2-salt and 3-salt fish. Unknown sex represented 2.5% of the recoveries. Composition of the run consisted of 49.7% Snake River hatchery by coded wire tag, 4.5% out-of-basin by wire, 12.7% unknown hatchery origin by AD clip, yearling scales or lost coded wire tag, and 33.1% unknown origin (unmarked/untagged fish that could be hatchery or natural origin).

Juvenile Salmon Emigration

2022 Outmigration Year

Juvenile fall Chinook salmon (BY21) were captured at the Tucannon River smolt trap (rkm 3.0) from 13 January through 22 July 2022 (Figure 20). The last day of trapping was 22 July. Most fish captured in the trap from January into the middle of May were newly emerged fry. Being so small, these fish are not used for trap efficiency tests, so the estimated number passing the trap provided below is a minimum. No fall Chinook were PIT tagged at the trap during the 2022

outmigration year. From the middle of May to the end of June, the mean size of fall Chinook migrants were 70 mm and 4.8 g (K-factor 1.19). Trapping efficiency for fall Chinook salmon ranged from 0.00% to 36.84%. Staff captured 4,296 (including 2 mortalities) fall Chinook salmon in 2022. Juvenile production of fall Chinook from the Tucannon River can be highly influenced by high stream flow events in the winter/early spring (Figure 21). Juvenile production can also be influenced by redd superimposition during large run years (mostly observed in lower river below the town of Starbuck, WA) and sediment input from Pataha Creek in some years.

From the middle of May to the end of July, we estimated that 37,587 (95% C.I. = 27,752-54,788) parr/smolts passed the trap. This estimate does not include fish that we captured but too small to run efficiency trials for, so this estimate is a minimum. Based on 211 fall Chinook salmon redds estimated above the smolt trap during 2021 spawning ground surveys, an estimated 178 smolts/redd were produced. After including potential production from redds below the smolt trap in 2022 (29 additional redds), we estimated that a minimum of 42,657 naturally produced fall Chinook salmon parr/smolts left the Tucannon River during 2022.

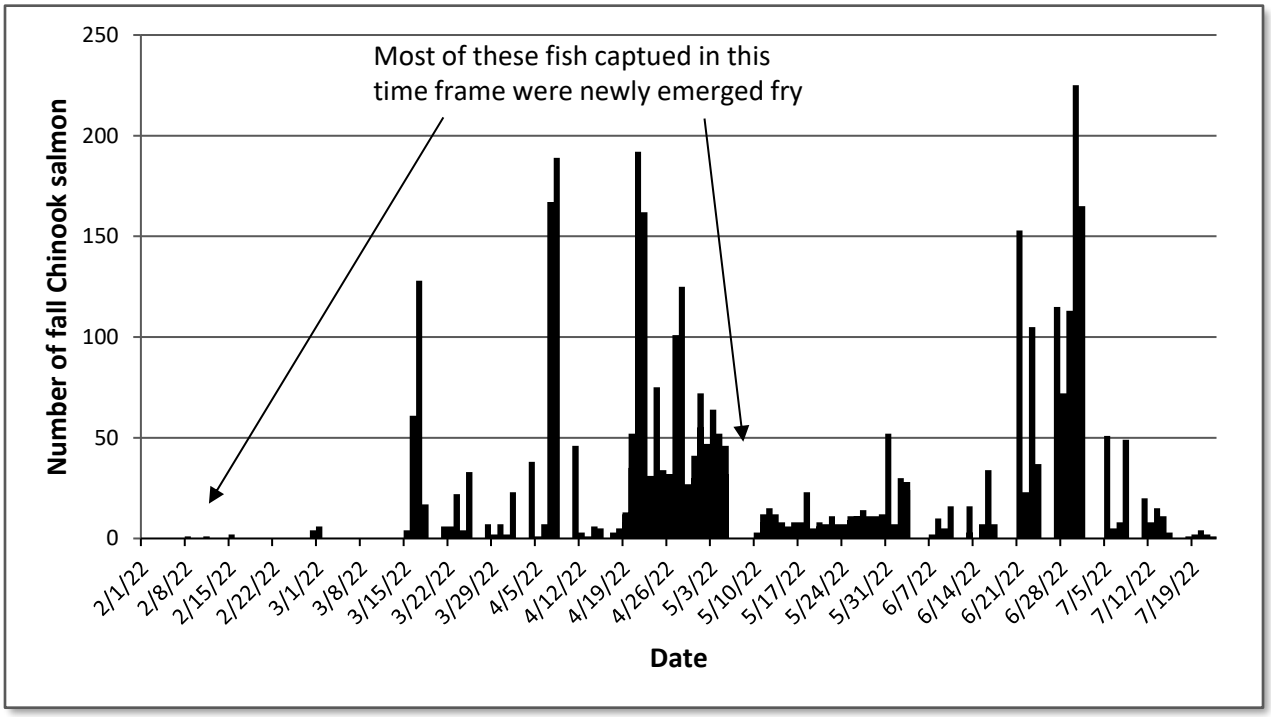

Figure 20. Migration timing of NOR juvenile fall Chinook salmon captured at the Tucannon River smolt trap in 2022.

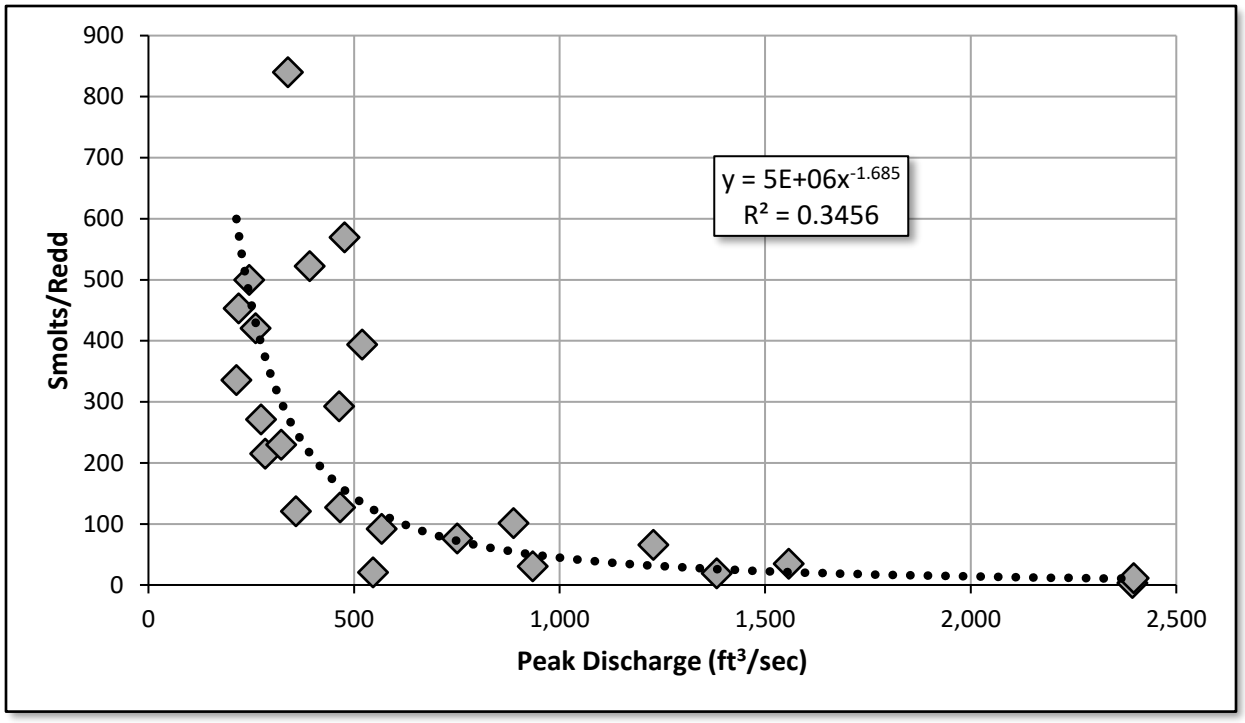

Figure 21. Peak discharge during fall Chinook incubation in the Tucannon River versus the estimated natural log of smolt/redd determined at the Tucannon River smolt trap.

Project Area Returns and Total Returns

As defined in the introduction, project area returns are calculated from the number of SRFCH salmon passing IHR. Strays from other Columbia River basin releases (Umatilla, Priest Rapids, Ringold, Klickitat, etc…) are known to cross IHR (Mendel et al 1993), and therefore inflate the number of fall Chinook counted into the Snake River, especially from IHR and Lower Monumental dams. The number of strays that reach LGR are considerably lower (generally <1%). Furthermore, the adult trap and sampling that occurs at LGR provides the best location to make an estimate of true SRFCH salmon. The systematic random sample of the fall Chinook run at LGR has been occurring since 2002 and provide the best dataset to estimate project area returns, as long as an estimate can be derived for fall Chinook that never make it back to LGR.

In the past, additional recoveries of fall Chinook from the Tucannon River and LFH adult trapping could be added to the estimate at LGR to estimate total project area returns. However, these estimates likely fell short of the true number due to fish spawning in locations that aren't regularly surveyed (in the tailraces below the dams, Palouse River), or from fishery removals. Another method that can be used to back-calculate the LGR run reconstruction estimate is using PIT tags, and their conversion rate from IHR to LGR. Hatchery origin fall

Chinook salmon released above LGR have very high conversion rates (generally >97%), while the releases from LFH are more variable (yearlings ~50%, subyearling ~80%). By applying year specific PIT tag conversion rates to the LGR run reconstruction estimate – most importantly to the LFH on-station releases that return to LGR, project area returns to IHR can be estimated.

Assumptions

To estimate return (to the project area, or total) of WDFW releases, certain assumptions were applied:

- Saltwater age of returning groups were estimated by subtracting one from the total age of subyearlings and subtracting two from the total age of yearlings. These estimates potentially underestimate jacks and overestimate adults because it does not consider the potential reservoir rearing of the subyearling component. However, for LFH on-station and GRR releases of subyearlings, the component that holds over for another year in the reservoir appears to be relatively small, minimizing the overall effect.

- Only AD+CWT marked/tagged fish were used to estimate returns. For many years, CWT only releases occurred in the on-station release of yearlings. Electronic sampling in areas outside the Snake River has been inconsistent or completely lacking (ocean fisheries). As such, determining returns from CWT only tagged fish was problematic and time consuming (Milks et al, 2016). Since this is a slightly different method than what was done previously, prior estimates of project area returns and total returns that were reported in previous fall Chinook annual reports were updated for inclusion within this report.

- The Regional Mark Processing Center (RMPC) website, www.rmpc.org, was queried on 23 February 2023 for any 2021 returns of CWT tagged fish associated with WDFW releases. Generally, most submissions to the RMPC database for the 2021 run year should have been finalized and submitted by this date.

In Tables 19-24 below, CWT recoveries were summed in a variety of ways to provide a more in-depth look at specific recoveries locations or recovery types. Totals from the tables may not add up to the same numbers provided in Table 19 or Table 20 due to rounding of estimates.

Returns to the Project Area

An estimated 5,785 fall Chinook salmon (adults+jacks) returned from WDFW releases into the project area in 2021, contributing to 21.1% of the LSRCP project area mitigation goal of 18,300

(Table 18) – however, ***this does not include the FCAP production fish*** also counted under the LSRCP program. The return in 2021 was the highest estimated since 2016. Low return years are most likely due to poorer ocean conditions that have been experienced in the last few years.

Table 18. Project area returns of WDFW released SRFCH salmon, 2003-2021 return years. The LSRCP Project Area goal (Lyons Ferry + Grande Ronde + all FCAP releases) is 18,300.

Run Year	LFH on-station yearling	LFH on-station subyearling	Grande Ronde subyearling	Couse Creek subyearling	Total return
2003	3,503	225			3,728
2004	7,680	401		37	8,111
2005	3,101	188		34	3,323
2006	2,439	208	62	8	2,724
2007	6,832	1,054	257	596	8,740
2008	3,896	1,263	142	861	6,162
2009	16,968	3,268	600	1,823	22,659
2010	11,719	2,137	1,297	1,207	16,360
2011	11,830	1,439	1,180	865	15,314
2012	9,240	1,932	1,877	1,555	14,604
2013	11,277	2,153	1,188	1,211	15,829
2014	7,895	1,570	1,557	1,254	12,277
2015	8,724	1,592	1,582	616	12,514
2016	4,209	1,412	1,326	383	7,330
2017	2,588	472	1,305	44	4,409
2018	3,616	910	807	0	5,333
2019	1,843	452	627		2,922
2020 [a]	1,066	1,110	1,403		3,579
2021 [a]	1,975	2,655	1,244		5,874

[a] These estimates include fish that were part of the FCAP program that were released at Lyons Ferry in 2019. Pittsburg landing was not operated that year, and some fish destined for Captain Johns or Big Canyon were also released on-site at LFH, all due to weather conditions.

Total Returns

An estimated 8,599 fall Chinook salmon (adults+jacks) returned from WDFW releases in 2021, contributing 9.4% of the combined project area goal and out-of-basin objectives (91,500 – Table 19) – however, this ***does not include the FCAP production fish*** also counted under the LSRCP program.

Table 19. Total returns of WDFW released SRFCH salmon, 2003-2021 return years. The LSRCP total mitigation target would be 91,500 adults (Lyons Ferry + Grande Ronde + all FCAP releases) and is inclusive of the 18,300 LSRCP Project Area goal.

Run Year	LFH on-station yearling	LFH on-station subyearling	Grande Ronde subyearling	Couse Creek subyearling	Total return
2003	6,350	483			6,833
2004	11,353	469		37	11,859
2005	6,527	329		52	6,908
2006	4,803	316	62	30	5,211
2007	10,704	1,178	370	729	12,981
2008	6,398	1,953	368	1,465	10,184
2009	23,428	3,703	878	2,392	30,401
2010	19,826	3,111	1,548	1,911	26,396
2011	17,507	2,160	1,717	1,545	22,929
2012	13,852	2,873	3,575	2,290	22,590
2013	16,463	3,263	2,963	2,518	25,207
2014	15,063	2,535	2,899	2,224	22,721
2015	13,853	2,295	3,270	1,115	20,533
2016	8,800	2,283	2,121	777	13,981
2017	5,887	1,084	2,451	110	9,532
2018	6,874	1,156	1,187	3	9,220
2019	2,804	661	816		4,281
2020 [a]	1,797	1,341	1,969		5,107
2021 [a]	3,217	3,491	1,891		8,599

[a] These estimates include fish that were part of the FCAP program that were released at Lyons Ferry in 2019. Pittsburg landing was not operated that year, and some fish destined for Captain Johns or Big Canyon were also released on-site at LFH, all due to weather conditions.

Harvest in the Project Area

In 2021, fall Chinook fisheries were open on the Snake River, including the boundary waters between Washington/Idaho, and in the Clearwater River. Recoveries of WDFW releases (including the FCAP fish released at LFH in 2019) were reported in the Regional Mark Information System (RMIS) database from these areas in 2022. The estimated CWT recoveries were expanded by the tag rate for each WDFW release group and provided below (Table 20).

Table 20. Estimated (and fully expanded by tag rate) Snake River basin harvest recoveries in 2021 of wire tagged fall Chinook salmon released by WDFW as reported to RMIS on 2/23/2023.

Group	1-Salt	2-4 Salt	Total ESTD	% by Group
LFH Yearling	136	38	174	***40.2%***
LFH Subyearling	38	105	143	***33.0%***
GRR Subyearling	8	108	116	***26.8%***
Total (All Groups)	***182***	***251***	***433***	

Recoveries by Region

From the download options in the RMIS database, CWT recoveries can be grouped into large geographic regions which is useful because SRFCH are recovered from California to Alaska, and within the Columbia River Basin. The majority (64.6%) of estimated CWT recoveries come from the Columbia River Basin (Table 21), followed next by recoveries off the coast of British Columbia, Washington, and Alaska (11.4%, 10.9%, and 9.4%respectively), and all other regions accounting for the remaining 3.7%.

Table 21. Fully expanded recovery estimates of tagged and untagged fall Chinook salmon recovered in all areas during the 2021 run year for WDFW releases. Minijacks are not included in the estimates.

	LFH – 1+		LFH – 0+		GRR – 0+		1+ and 0+ Combined	
Region	**EST total recoveries**	**% by region**	**EST total recoveries**	**% by region**	**EST total recoveries**	**% by region**	**EST total recoveries**	***Percent by region***
Freshwater (Columbia Basin)	1,329	***68.4%***	857	***68.3%***	369	***48.6%***	2,555	***64.6%***
CA	9	***0.5%***	0	***0.0%***	14	***1.8%***	23	***0.6%***
OR	34	***1.8%***	33	***2.6%***	58	***7.6%***	125	***3.2%***
WA	222	***11.4%***	135	***10.8%***	74	***9.7%***	431	***10.9%***
BC	219	***11.3%***	99	***7.9%***	133	***17.5%***	451	***11.4%***
AK	129	***6.6%***	131	***10.4%***	112	***14.7%***	372	***9.4%***
HS	0	***0.0%***	0	***0.0%***	0	***0.0%***	0	***0.0%***
Totals	***1,887***	***49.1%***	***1,255***	***31.7%***	***760***	***19.2%***	***3,957***	

Recoveries in the Ocean

Within the ocean, CWT recoveries can be split into a variety of fishery types, with the most common being Troll (both Treaty and non-Treaty), Gillnet/Seine fisheries, Trawl (salmon captured as bycatch), and Sport. For the WDFW releases that returned in 2021, nearly 63% of the estimated CWT recoveries were recovered from the troll fisheries (both types), followed by sport fisheries at 26.9%, with gillnet/seine and trawl fisheries making up less than 10% of the recoveries (Table 22).

Table 22. Fully expanded recovery estimates of tagged and untagged fall Chinook salmon recovered in the Pacific Ocean during the 2021 run year for WDFW releases. Minijacks are not included in the estimates.

Region [a]	Fishery	LFH – 1+ Total Estimate	LFH – 0+ Total Estimate	GRR – 0+ Total Estimate	*Grand Total*	*%*
CA	Troll		0	14	***14***	***1.0%***
	Sport	12	0		***12***	***0.9%***
OR	Troll	9	7	45	***61***	***4.3%***
	Trawl		4		***4***	***0.3%***
	Sport	25	22	13	***60***	***4.3%***
WA	Troll	66	64	29	***159***	***11.3%***
	Trawl	2			***2***	***0.1%***
	Troll (Treaty)	32	44	15	***91***	***6.5%***
	Test Fishery	2			***2***	***0.1%***
	Sport	124	26	30	***180***	***12.8%***
BC	Troll	167	84	77	***328***	***23.3%***
	Sport	54	15	55	***124***	***8.8%***
AK	Troll	66	46	109	***221***	***15.7%***
	Gillnet/Seine	60	79	3	***142***	***10.1%***
	Sport	4	6		***10***	***0.7%***
HS	Trawl				***0***	***0.0%***
Totals		***623***	***397***	***390***	***1,410***	
	Fishery Type	**Total Estimate**	**Total Estimate**	**Total Estimate**	***Grand Total***	
All Regions Combined	Troll	340	245	289	***874***	***62.0%***
	Gillnet/Seine	62	79	3	***144***	***10.2%***
	Trawl	2	4	0	***6***	***0.4%***
	Sport	219	69	98	***386***	***27.4%***

[a] Regions defined: CA = California; OR = Oregon; WA = Washington; BC = British Columbia; AK = Alaska; HS = High Sea

Recoveries in the Columbia River Basin (excluding the Snake River)

Within the Columbia River, CWT recoveries can be split into a variety of fishery types (Gillnet and sport) and zones (Estuary, Zone 1-5, and Zone 6), other hatcheries and on the spawning ground (SGS). For the 2021 run, the following summary is provided (excluding recoveries in the Snake River basin (Table 23)). As with previous years, most recoveries come from the Columbia River Net Fisheries (50.8%), with sport fisheries accounted for about 46.6%, and fish recovered at other hatcheries of fish traps outside of the Snake River basin at 2.6%.

Table 23. Fully expanded recovery estimates of tagged and untagged fall Chinook salmon recovered in the Columbia River Basin (all freshwater areas – but excluding Snake River Basin recoveries) during the 2021 run year for WDFW releases. Minijacks are not included in the estimates.

Recovery area	Fishery/Hatchery/River	LFH – 1+ Total Estimate [a]	LFH – 0+ Total Estimate [a]	GRR – 0+ Total Estimate [a]	*Grand Total*	*%*
COL R Gillnet	Zone 1-5 Commercial	127	30	47	***204***	***15.9%***
	Zone 6 Tribal Net	229	131	88	***448***	***34.9%***
COL R Sport	COL R Estuary	63	176	42	***281***	***21.9%***
	Zone 1-5 sport	224	63	24	***311***	***24.3%***
	Zone 6 Sport	3	0	2	***5***	***0.4%***
	Handford Reach	0	0	0	***0***	***0.0%***
Hatchery	Priest Rapids	13	0	2	***15***	***1.2%***
	Ringold Springs	3	0	1	***4***	***0.3%***
	Three Mile Dam	3	11	0	***14***	***1.1%***
SGS	Hanford Reach	0	0	0	***0***	***0.0%***
Totals		***665***	***411***	***206***	***1,282***	

Smolt-to-Adult Survival Rates (SAR and SAS)

Within the original Special Report - Lower Snake River Fish and Wildlife Compensation Plan (COE 1975), smolt-to-adult return rates (SAR) to the defined project area for SRFCH were assumed to be 0.2%. This assumed rate, along with brood needs based on fecundity, egg-to-smolt survivals, numbers of smolts, and fish per pound at juvenile release were used to size the hatchery program at LFH. Of course, since that time, additional hatchery SRFCH production programs in the Snake River have been added, and changes as to how the hydrosystem is managed (bypass and spill) is much different than what was occurring in 1970's.

At LFH, yearling and subyearling releases have occurred almost annually since 1985. Early in the program, yearling fall Chinook survived much better than subyearlings (Bugert et al 1997 – about a 10-fold difference). With management changes to the hydropower system (bypass and spill, and summer flow augmentations from Dworshak Reservoir), and changes to the subyearling release size, survival rates between yearling and subyearling releases are much closer. For LFH releases, subyearlings perform on average about ½ as well as yearling releases back to the project area when jack returns are excluded (Table 24). However, yearling releases are known to produce proportionally more mini-jacks and jacks per adult compared to subyearling releases. When jacks are included, the average performance difference is about 1/3 between subyearlings and yearlings. Other WDFW subyearling release locations upstream of LGR have also occurred, these generally survive at a lower rate compared to the LFH on-

station release of subyearlings (Table 25). Migration distance and perhaps predation are likely factors for the differences observed between upstream and below LGR release sites.

As shown in the adult return sections, SRFCH are harvested from a variety of locations and fisheries. Generally, about 35-50% of the returns are taken before they return to the project area. This is reflected in the differences between the SAR and SAS rates for each release group in Tables 25 and 26.

Table 24. Smolt-to-adult return (SAR) rates to the LSRCP project area for yearling (LFH 1+) and subyearling (LFH 0+ - LFH On-station release; GRR 0+ - Grande Ronde River release; CCD 0+ - Couse Creek release) fall Chinook salmon by WDFW, 2002-2018 release years.

Release	Adults and Jacks Combined				Adults Only			
Year	LFH 1+	LFH 0+	GRR 0+	CCD 0+	LFH 1+	LFH 0+	GRR 0+	CCD 0+
2002	1.34%	0.22%			0.83%	0.18%		
2003	1.28%	0.11%		0.08%	0.33%	0.05%		0.04%
2004	0.16%	0.06%			0.07%	0.04%		
2005	0.83%	0.07%	0.02%	0.01%	0.39%	0.03%	0.02%	0.01%
2006	1.54%	1.16%	0.12%	0.75%	0.41%	0.71%	0.14%	0.30%
2007	0.90%	0.19%			0.49%	0.08%		
2008	4.85%	2.42%	0.45%	1.19%	1.63%	1.09%	0.29%	0.53%
2009	2.01%	0.28%	0.21%	0.23%	1.12%	0.14%	0.13%	0.20%
2010	2.55%	1.08%	0.76%	0.85%	0.99%	0.66%	0.64%	0.61%
2011	1.71%	1.52%	0.20%	1.07%	0.90%	1.06%	0.12%	0.75%
2012	2.45%	0.47%	0.48%	0.26%	0.94%	0.33%	0.48%	0.26%
2013	1.85%	1.00%	0.30%	0.48%	1.10%	0.67%	0.24%	0.37%
2014	1.08%	0.46%	0.25%		0.44%	0.24%	0.23%	
2015	0.62%	0.44%	0.39%		0.31%	0.22%	0.27%	
2016	0.93%	0.13%	0.01%		0.67%	0.12%	0.01%	
2017	0.39%	0.24%	0.26%		0.27%	0.16%	0.16%	
2018	0.21%	0.21%	0.38%		0.17%	0.15%	0.28%	
Average	***1.45%***	***0.59%***	***0.29%***	***0.55%***	***0.65%***	***0.35%***	***0.23%***	***0.34%***
Geomean	***1.07%***	***0.35%***	***0.19%***	***0.30%***	***0.51%***	***0.21%***	***0.15%***	***0.20%***

Table 25. Total Smolt-to-adult survival (SAS) rates for yearling and subyearling fall Chinook salmon by WDFW, 2002-2018 release years.

Release Year	Adults and Jacks Combined				Adults Only			
	LFH 1+	LFH 0+	GRR 0+	CCD 0+	LFH 1+	LFH 0+	GRR 0+	CCD 0+
2002	2.06%	0.30%			1.42%	0.26%		
2003	2.04%	0.15%		0.11%	0.86%	0.08%		0.07%
2004	0.50%	0.11%			0.34%	0.08%		
2005	1.65%	0.08%	0.05%	0.02%	0.98%	0.04%	0.05%	0.03%
2006	2.16%	1.67%	0.24%	1.21%	0.76%	1.19%	0.26%	0.56%
2007	1.51%	0.24%			0.94%	0.13%		
2008	7.24%	3.13%	0.52%	1.73%	3.08%	1.75%	0.36%	1.01%
2009	3.25%	0.46%	0.35%	0.41%	2.02%	0.30%	0.27%	0.37%
2010	3.64%	1.71%	1.50%	1.42%	1.73%	1.28%	1.36%	1.15%
2011	2.77%	2.16%	0.39%	1.86%	1.76%	1.66%	0.31%	1.51%
2012	4.06%	0.78%	1.01%	0.47%	2.25%	0.63%	0.99%	0.46%
2013	3.06%	1.49%	0.57%	0.82%	2.07%	1.14%	0.49%	0.70%
2014	1.89%	0.68%	0.35%		1.10%	0.46%	0.32%	
2015	1.29%	0.70%	0.68%		0.83%	0.46%	0.54%	
2016	1.66%	0.20%	0.02%		1.31%	0.19%	0.02%	
2017	0.63%	0.28%	0.36%		0.45%	0.20%	0.26%	
2018	0.31%	0.31%	0.54%		0.26%	0.25%	0.44%	
Average	***2.34%***	***0.85%***	***0.51%***	***0.89%***	***1.30%***	***0.59%***	***0.44%***	***0.65%***
Geomean	***1.82%***	***0.50%***	***0.34%***	***0.50%***	***1.08%***	***0.35%***	***0.29%***	***0.40%***

Direct Take of Listed Snake River fall Chinook Salmon During Fall of 2021 and Spring of 2022

"Take" estimates for permit #16607-2R for LFH production and permit #16615-2R for NPTH production are reported annually in the WDFW Fall Chinook report to LSRCP and other reports (see list below and Table 27). The Section 10 "Take" tables were updated following the 2018 NOAA consultation of the program (Section 10 Permits 16607-2R and 16615-2R). In 2021, new WDFW staff were attempting to fill out the Section 10 "take" tables for this annual report. Due to some inconsistent, and awkward footnote language associated with the tables, WDFW and NPT staff reached out to NOAA Fisheries for clarification. During those discussions with NOAA Fisheries, it was decided that restructuring of the "take" table and associated footnotes needed to occur, making them more similar/consistent with other Snake River Basin permits (e.g., NE Oregon/SE Washington spring Chinook permits). WDFW and NPT staff submitted updated versions of the Fall Chinook Section 10 "take" tables to NOAA Fisheries. To date, we are still in the process of finalizing the Section 10 "take" tables for these two permits.

To complete this report per LSRCP requirements, estimates of "take" associated with this program for the 2019 to 2021 spawns and juvenile releases from 2020-2022 will be reported in future WDFW Fall Chinook reports to LSRCP. In addition, during consultation, it was agreed that additional reporting requirements were needed to cover the Terms and Condition section of the Section 10 permits and Section 7 Biological Opinion reporting requirements, with the timeframe beginning in 2018. The information required is provided in Section 10 permit 16607-2R as specified in the Special Conditions, Research, Monitoring, and Evaluation section (page 9-10) and the Permit Reporting and Reauthorization Requirements (C-5a, i-ix). Information needed is included as tables in this document or was obtained and cited from the following documents (see list and Table 26).

Additional information can also be found in reports provided by the NPT and are referred to in the Conditions Table (Table 26) provided below.

1. Nez Perce Tribe Snake River Fall Chinook Salmon Monitoring and Evaluations Report (**M&E Report**)
2. 2021 Snake River Fall Chinook Salmon Spawning Summary Report (**Redd Report**)
3. Final abundance and composition of Snake River Fall Chinook salmon returning to Lower Granite Dam in 2021 (**Run Recon Report**)
4. 2021 NPTH SR fall Chinook production report (**Production Report**)

Table 26. Terms and Conditions for WDFW Section 10 Permit #16607-2R (2018).

Conditions	Response or reference for requested information
Annual adult return estimates for all ESA-listed salmonids encountered at the LGR adult trap.	See ESA permit 21951; LGR trapping permit (NOAA)
Fall Chinook salmon escapement to LFH, NPTH and the South Fork Clearwater Weir (once in operation) by origin (marked, tagged, unknown and unmarked adults);	The LFH trap was not operated in 2021. Escapement to NPTH provided in **NPTH Production Report**. The South Fork Clearwater trap was not operated in 2021.
Annual estimates of fall Chinook salmon escapement, and fall Chinook salmon redd counts, in natural spawning areas	Fall Chinook salmon escapement to the Tucannon River is provided in Table 17 in this report. Fall Chinook salmon escapement to natural spawning areas above LGR are described the **NPTH M&E report**. Fall Chinook salmon redd counts above LGR are described in the **NPTH M&E report** and in the **NPT Redd report**
Carcass recovery data, including numbers, sex ratios, fish stock origin, mark observations, tributary location, and age class	Carcass recovery data from the Tucannon River is provided on Table 16 in this report. Carcass recovery data above LGR provided by NPT in the **M&E report** Hatchery Fraction section and the "carcass" tab provided by NPT Permit Spreadsheet.
Number and origin of all fall Chinook salmon retained during broodstock collection and their final disposition	Number and origin of broodstock retained at LFH are provided in Table 9, page 19 in this report. For the number of broodstock retained and their disposition by NPTH, see the **NPT M&E report**. Also see the joint agency **Run Recon report** for additional information.
Trends in the relative, total annual abundances of NOR and HOR fall Chinook salmon escaping to the Snake River Basin upstream of LGR, and observations of any apparent effects of the hatchery program on fall Chinook salmon escapement and spawning	See the joint Agency **Run Recon report** for trends in total abundance of NOR and HOR fall Chinook salmon escaping to LGR; see "escapement" tab for trends in abundance of NOR and HOR fall Chinook escaping above LGR and see the **Redd report** for trends in index of abundance (redd counts) above LGR.

Conditions	Response or reference for requested information
distributions in the Snake River Basin	
Unintentional injuries or mortalities of listed spring/summer, and fall Chinook salmon, steelhead, and sockeye that result from all operational activities	Captures of fall Chinook juveniles during RM&E activities by WDFW (Tucannon Smolt trapping) are provided in the smolt trapping section of this report (pages 32-34). Incidental trapping of juveniles (spring Chinook or steelhead) in the Tucannon River are covered under other Section 10 reports. Incidental trapping of ESA-listed adult steelhead, spring Chinook salmon and sockeye salmon at the LFH adult trap is not available as the trap did not operate in 2021.

Recommendations and Conclusions

The fall Chinook salmon program at LFH is being managed to meet the goals and objectives of State, Tribal and Federal co-managers and requires substantial coordination. Conclusions and recommendations listed below are not prioritized and represent the opinion of WDFW Snake River Lab Evaluation staff.

1. As of 2016, PBT sampling at LGR was able to detect all in-basin hatchery returns which allows more precise (in theory) estimates of NOR fish in the overall return, and those that contribute to broodstock. Beginning with the 2019 release year and into the future, all SRFCH salmon releases will be identified by a PBT mark group at each release site.

Recommendation: In the future, work with the SRFCH salmon run reconstruction technical group and Snake Basin geneticists to derive run reconstruction estimates based solely on PBT results and compare to the standardized CWT based run reconstruction estimates. Following these comparisons, begin discussions regarding the future tagging levels/use/need of CWT's for SRFCH salmon. In addition, continue to work with the FINS technical team to upload fall Chinook spawning, rearing and release data to reference future returns by origin for the PBT analysis.

2. Fish from SRFCH yearling programs have generally shown a higher SAR rate as compared to subyearling releases. However, yearlings have a very high rate of 0-salt and 1-salt returns whereas subyearlings do not return as 0-salt fish and generally have lower returns of 1-salt fish. Beginning in 2020, releases of yearlings above LGR were ceased, but the release of yearlings at LFH have continued. A Snake River Basin wide discussion was initiated by WDFW to discuss the possible elimination of future yearling releases at LFH, with additional subyearling production (released at LFH, but also in other locations above LGR) so no net loss of returns would occur (Adult + Jack combined), and downriver or ocean fisheries should not be negatively impacted. A "white paper" was completed in the spring of 2022 (Appendix H). Following that, all Snake Basin parties agreed to move a proposal forward through the Production Advisory Committee to eliminate the yearling releases, with additional subyearling production at LFH and upstream of Lower Granite Dam. This change is tentatively planned for brood year 2024 and would be implemented pending needed ESA consultations by the USFWS and NOAA Fisheries.

Recommendation: Continue to work with NOAA Fisheries to complete consultation requirements so the change can tentatively occur with brood year 2024.

3. Since the late 1980's, WDFW evaluation staff have been conducting redd surveys in the lower Tucannon River to count and estimate fall Chinook redds. Beginning in 1997, coho salmon began returning to the Snake River basin from Tribal re-introduction efforts in the Columbia/Snake rivers. At that same time, WDFW staff began to periodically recover coho salmon carcasses and "observe" what were thought to be coho redds (based on size and location in the stream). However, it soon became apparent that some fall Chinook redds (made by "jills" from the hatchery yearling releases, or smaller 2-salt subyearlings) were in similar stream locations and with redd sizes similar to what are typically thought of as coho redds. These "observational" redd designations are further complicated by varied stream conditions and observer experience.

Over the past two years, evaluation staff have revisited all previous fall chinook/coho spawning ground survey data. A standard methodology was developed to consistently 1) estimate redds in locations that can't be surveyed due to landowner access issues, and 2) when surveys are incomplete because of high stream flow conditions that sometimes happen near the end of the season. As part of this standardization process, it was discovered that the proportion of fall Chinook to coho salmon counted at the Lower Monumental Dam fish ladder are very similar to what has been estimated in the Tucannon River as determined from carcass or "observational" redd estimates. This is significant because nearly all the coho salmon returning to the Snake River are not destined for the Tucannon River. Coho salmon natural production in the Tucannon River as determined by smolt trap catches would suggest that not many would likely return as adults.

Conclusion: As explained earlier in the report, WDFW evaluation staff completed their evaluation of all three possible estimation methods. To provide a consistent and likely more reliable estimates in the future, it was decided to adopt the proportion of fall Chinook to coho from Lower Monumental Dam window counts applied to the total number of estimated redds. Staff will most likely continue to make "observational" notes regarding redd origin, and recovered carcasses will continue to provide a back-up should we start to see deviations from the current relationship.

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Appendix A: Trapping and Sampling Protocols at LGR Adult Trap for 2021

2021 Fall Chinook Trapping / Sampling Protocols at LGR
August 18, 2021

Protocols:

1) This protocol assumes a 24 hour/day, 7 days per week trapping at 70% continuing through September 4th, and then dropping to 18% through the end of the season.

   70% trapping period : WILL RECEIVE an operculum punch on the left side (LOP)
   18% trapping period: NO operculum punch.

2) Males and females will not be inoculated.

3) All fish ≥ 70 cm will be hauled to LFH and NPTH. LFH will haul ~70% and the NPT will haul ~30%.

4) Wire tagged FEMALES >29cm to <70cm will be hauled to LFH and NPTH (1 out of 3 trapped).

5) Wire tagged MALES >29cm to <70cm will be hauled to LFH only (1 out of 3 trapped).

6) Only scale sample non-Wire tagged fish released from the trap. Do not scale sample hauled fish.

7) DNA sample all fish trapped (hauled or released).

WIRE TAGGED FISH

Fork Length	Action
≥ 70cm	Haul all fish (DNA sample all)
>29cm to <70cm	Haul 1 out of 3 wire tagged FEMALES for LFH and NPT [100% DNA] Haul 1 out of 3 wire tagged MALES for LFH (LFH only tank) [100% DNA] Released wire tagged Males +Females (2 of 3) [100% DNA]

UNTAGGED FISH :

Fork Length	Action
≥ 70cm	Haul all fish (DNA sample all)
>29cm to <70cm	Release All [100% Scale, 100% DNA]

2021 Fall Chinook Trapping / Sampling Protocols at LGR

Protocol Change to Begin September 8th, 2021

Protocols:

1) This protocol assumes a 24 hour/day, 7 days per week trapping at 70% continuing through September 4th, and then dropping to 18% through the end of the season.

   70% trapping period : WILL RECEIVE an operculum punch on the left side (LOP)
   18% trapping period: NO operculum punch.

2) Males and females will not be inoculated.

3) All fish ≥ 75 cm will be hauled to LFH and NPTH. LFH will haul ~70% and the NPT will haul ~30%.

4) Wire tagged FEMALES >29cm to <70cm will be hauled to LFH and NPTH (1 out of 3 trapped).

5) Wire tagged MALES >29cm to <70cm will be hauled to LFH only (1 out of 3 trapped).

6) Only scale sample non-Wire tagged fish released from the trap. Do not scale sample hauled fish.

7) DNA sample all fish trapped (hauled or released).

WIRE TAGGED FISH

Fork Length	Action
≥ 75cm	Haul all fish (DNA sample all)
≥ 70cm to < 75cm	Release All (100% DNA)
>29cm to <70cm	Haul 1 out of 3 wire tagged FEMALES for LFH and NPT [100% DNA] Haul 1 out of 3 wire tagged MALES for LFH (LFH only tank) [100% DNA] Released wire tagged Males +Females (2 of 3) [100% DNA]

UNTAGGED FISH :

Fork Length	Action
≥ 75cm	Haul all fish (DNA sample all)
≥ 70cm to < 75cm	Release All (100% Scale, 100% DNA)
>29cm to <70cm	Release All [100% Scale, 100% DNA]

2021 Fall Chinook Trapping / Sampling Protocols at LGR

Protocol Change to Begin September 18th, 2021

Protocols:

1) This protocol assumes a 24 hour/day, 7 days per week trapping at 70% continuing through September 4th, and then dropping to 18% through the end of the season.
   70% trapping period : WILL RECEIVE an operculum punch on the left side (LOP)
   18% trapping period: NO operculum punch.
2) Males and females will not be inoculated.
3) All fish ≥ 75 cm will be hauled to LFH and NPTH. LFH will haul ~70% and the NPT will haul ~30%.
4) Wire tagged FEMALES >29cm to <70cm will be hauled to LFH and NPTH (1 out of 3 trapped).
5) Wire tagged MALES >29cm to <70cm will be hauled to LFH only (1 out of 3 trapped).
6) Only scale sample non-Wire tagged fish released from the trap. Do not scale sample hauled fish.
7) DNA sample all fish trapped (hauled or released).
8) For the NPTH collections from 9/18-9/20, collect a total 7 females only (≥ 75cm) and any males per the protocol below. Any additional females ≥ 75cm captured during the normal NPTH collection period will be held in a separate tank so they can be hauled to Lyons Ferry. WDFW will send a truck on Monday if needed to collect these females.

WIRE TAGGED FISH

Fork Length	Action
≥ 75cm	Haul all fish (DNA sample all) – Collect up to 7 females only for NPTH
≥ 70cm to < 75cm	Release All (100% DNA)
>29cm to <70cm	Haul 1 out of 3 wire tagged FEMALES for LFH ~~and NPT~~ [100% DNA] Haul 1 out of 3 wire tagged MALES for LFH (LFH only tank) [100% DNA] Released wire tagged Males +Females (2 of 3) [100% DNA]

UNTAGGED FISH :

Fork Length	Action
≥ 75cm	Haul all fish (DNA sample all) – Collect up to 7 females only for NPTH
≥ 70cm to < 75cm	Release All (100% Scale, 100% DNA)
>29cm to <70cm	Release All [100% Scale, 100% DNA]

2021 Fall Chinook Trapping / Sampling Protocols at LGR

Protocol Change to Begin September 21st, 2021

Protocols:

1) This protocol assumes a 24 hour/day, 7 days per week trapping at 70% continuing through September 4th, and then dropping to 18% through the end of the season.
   70% trapping period : WILL RECEIVE an operculum punch on the left side (LOP)
   18% trapping period: NO operculum punch.
2) Males and females will not be inoculated.
3) Only scale sample non-Wire tagged fish released from the trap. Do not scale sample hauled fish.
4) DNA sample all fish trapped (hauled or released).

WIRE TAGGED FISH

Fork Length	Action
≥ 75cm	Haul all Males, Release All Females (DNA sample all)
≥ 70cm to < 75cm	Release All (100% DNA)
>29cm to <70cm	Release all Females [100% DNA] Haul 1 out of 3 wire tagged MALES for LFH (LFH only tank) [100% DNA]

UNTAGGED FISH :

Fork Length	Action
≥ 75cm	Haul all Males, Release all Females (100% Scale on Females, DNA sample all)
≥ 70cm to < 75cm	Release All (100% Scale, 100% DNA)
>29cm to <70cm	Release All [100% Scale, 100% DNA]

2021 Fall Chinook Trapping / Sampling Protocols at LGR

Protocol Change to Begin September 30th, 2021

Protocols:

1) This protocol assumes a 24 hour/day, 7 days per week trapping at 70% continuing through September 4th, and then dropping to 18% through the end of the season.
   70% trapping period : WILL RECEIVE an operculum punch on the left side (LOP)
   18% trapping period: NO operculum punch.
2) Males and females will not be inoculated.
3) Only scale sample non-Wire tagged fish released from the trap. Do not scale sample hauled fish.
4) DNA sample all fish trapped (hauled or released).

WIRE TAGGED FISH

Fork Length	Action
≥ 70cm	Release All (100% DNA)
>29cm to <70cm	Release All [100% DNA]

UNTAGGED FISH :

Fork Length	Action
≥ 70cm	Release All (100% Scale, 100% DNA)
>29cm to <70cm	Release All [100% Scale, 100% DNA]

Appendix B: Systematic Sampling Rates at Lower Granite Dam 2003-2021

Appendix B Table 1. Dates, times, and trapping rates of fall Chinook salmon at LGR, 2003-2020.

Year	Date opened trap	Trap rate (%)	Date trap closed	Date/time trapping rate changed	Modified trapping rate (%)	Date/time trapping rate changed	Adjusted trapping rate (%)	Date trap closed
2003	9 Sept	11	-	-	nc [a]	-	nc	19 Nov
2004	2 Sept	15	3&5 Sept [b]	10 Sept	13	-	nc	22 Nov
2005	6 Sept	13	-	-	nc	-	nc	20 Nov
2006	1 Sept	13	-	-	nc	-	nc	21 Nov
2007	1 Sept	20	-	-	nc	-	nc	20 Nov
2008	24 Aug 8:00 am [c]	20	-	12 Sept 2:52 pm	12	26 Sept 3:00 pm	10	21 Nov
2009	18 Aug 7:37 am	12	-	9 Sept 7:25 am	9	-	nc	15 Nov
2010	22 Aug 11:05 am	12	10 Sept-10:50 am [d] 18 Sept-10:50 am [b]	18 Sept 3:00 pm	10	-	nc	18 Nov
2011	18 Aug 10:30 am	10	-	-	nc	-	nc	21 Nov
2012	28 Aug 10:36 am	15	-	-	nc	-	nc	19 Nov
2013	23 Sept 10:07 am	12	27 Sept- 3:00 pm [e]	1 Oct 2:22 pm	15	8 Oct 2:22 pm	20	24 Nov
2014	18 Aug 9:54 am	100	19&20 Aug [f] 22-29 Aug [f]	1 Sept 8:38 am	10	2 Oct 7:40	8	11 Nov
2015	22 Aug 7:55 am	100	23-26 Aug [f] 29 Aug [f]	31 Aug 8:39 am	12	-	nc	22 Nov
2016	18 Aug 8:28 am	19	-	-	nc	-	nc	20 Nov
2017	18 Aug 7:45 am	20	-	13 Sept	33	22 Sept	20	19 Nov
2018	18 Aug 7:00 am	70	-	8 Sept	20		nc	18 Nov
2019	18 Aug	70	6-12 Sept 8:06 am [f]	6 Sept	20	12 Sept 4:00pm 17 Sept	100 20	12 Nov
2020	18 Aug	80	-	2 Sept	18	-	nc	12 Nov
2021	18 Aug	70	3-6 Aug 7:30am [f]	2 Sept	18	-	nc	18 Nov

[a] No change (nc) was made to the trapping rate.
[b] Trap was closed for two hours each day.
[c] Trap was operated between 8-8:30 am, then 12:30-12:55 pm, then 2:20-3:02 pm on 24 Aug due to water temperature restrictions. Full operation began 25 August
[d] Trap was closed at 10:50 am for three hours due to large numbers of fall Chinook salmon.
[e] Trap was closed at 3:00 pm for two hours due to large numbers of fall Chinook salmon.
[f] Trap closed due to high water temperatures.

Appendix C: Salmon Processed and Killed at LFH in 2021

(Age/Rearing states origin, brood year, age at release, and release site (LF21SO is a LFH HOR fish from the 2021 brood year, released as a subyearling, on-station at LFH).

Appendix C Table 1: Estimated composition of non-wire tagged salmon trapped at LGR, hauled to LFH, and killed during 2021.

Age/Origin Determinations by Method	Females	< 53 cm Males	≥53 cm Males	Grand Total
Snake R. HOR				**806**
Subyearling	491		237	728
Yearling	3		1	4
Unknown rear/age	50		24	74
Snake R. NOR				**499**
Subyearling	281		137	418
Yearling	12		5	17
Unknown rear/age	37		27	64
Unknown HOR				**4**
Subyearling			2	
Yearling				
Unknown rear/age			2	
Stray HOR				**9**
Subyearling	5		3	8
Yearling				
Unknown rear/age				1
Unknown Origin				**5**
Subyearling	2		3	5
Yearling				
Unknown Origin Unknown rear/age				
Total	**882**		**441**	**1323**

Appendix C Table 2. Estimated composition of wired salmon trapped at LGR, hauled to LFH, and killed in 2021.

Origin by CWT	CWT	Females	<53 cm Males	≥53 cm Males	Grand Total
LF15YO	637041	1			1
LF16SGRRD	637199	1			1
LF16SO	220382	1			1
LF16SPLA	091138	1		1	2
LF16YBCA	220388	1		1	2
	220391	1			1
LF16YCJA	220389	1			1
	220392	1		1	2
LF16YO	637202	6			6
	637203	3			3
LF16YPLA	220387			1	1
	220390			1	2
LF17SBCA	220504	13		1	14
	220505	14		8	22
LF17SCJA	220502	17		8	25
	220503	16		4	20
	220508	8		4	12
LF17SGRRD	637395	19		7	26
LF17SO	637394	11		1	12
LF17SPLA	220506	12		6	18
	220507	17		3	20
LF17SSAL	091185	47		9	56
LF17YLCPB	220393	8		6	14
	220394	4		5	9
	220395	2			2
	220396	4		4	8
	220397			1	1
	220398	2			2
LF17YO	637397	4		8	12
	637398	2		4	6
LF18SBCA	220511	6		24	30
	220512	2		12	14
LF18SCJA	220509	7		27	34
	220510	12	1	20	33
LF18SGRR	637420	5	3	31	39
LF18SIPCSAL	091286	9	1	34	44
LF18SO	637422	4		21	25
LF18SPLA	220513	16		23	39
	220514	1		21	22
LF18YO	637603	4	12	72	88
LF19SBCA	220197		3		3
LF19SCJA	220195		7	1	8
	220196		3		3
LF19SGRR	637759		1		1
LF19SIPCSAL	091459		4		4
LF19SO	637758	1	8		9
LF19SPLA	220199		5		5
	220282		3		3
LF19YO	637762		57		57
NPTH15SO	220250			1	1

Origin by CWT	CWT	Females	<53 cm Males	≥53 cm Males	Grand Total
NPTH16SCFA	220252	1			1
	220253			5	5
NPTH16SLGA	220261	1		1	2
	220262	1		1	2
NPTH16SO	220256	1			1
	220257	4		1	5
	220260	1		1	2
NPTH17SLGA	220271	21		10	31
NPTH17SNLVA	220258	39		22	61
NPTH17SO	220266	17		2	19
	220268	20		7	27
NPTH18SLAP	220270	1		4	5
NPTH18SLGA	220269	3		6	9
NPTH18SO	220267			7	7
	220272			6	6
BONN17YUMA	091276	1			1
	091279	1		1	2
BONN18YUMA	091403		1		1
KLICK16SO	637194	1			1
LRH19SPCH	637662		1		1
PRIEST17SCOLR	637356			1	1
PRIEST18SCOLR	637521			1	1
RINGOLDSPRINGS17SPRINGSCR	019255	2			2
Total		**399**	**110**	**447**	**957**

Appendix D: Historical Use of Minijacks, Jacks, Jills and Strays in Broodstock at LFH

Appendix D Table 1. Number of matings of minijacks, jacks, and jills contributing to broodstock at LFH 2000-2009 and 2010-2021 during size-selective mating protocols.

Year	0-salt	1-salt jack	1-salt jill	Number of matings containing jack x jill mating	% of total matings with 0-salt and/or 1-salt parentage
2000	195	609	157	127	80.4
2001	9	876	67	47	67.6
2002	4	480	11	9	24.7
2003	3	527	78	63	74.5
2004	28	943	254	204	77.3
2005	14	611	57	25	45.4
2006	1	519	121	91	70.0
2007	0	1138	480	408	83.0
2008	0	345	80	30	30.2
2009	1	539	503	143	69.6
Average	**26**	**659**	**181**	**115**	**62.3**
2010	0	38	2	0	3.2
2011	0	50	37	3	6.7
2012	0	2	3	0	0.4
2013	0	9	45	1	4.3
2014	0	0	0	0	0.0
2015	0	2	1	0	0.1
2016	0	5	3	0	0.6
2017	0	22	14	0	2.8
2018	0	5	0	0	0.4
2019	0	0	1	0	0
2020	0	0	0	0	0
2021	**0**	**0**	**3**	**0**	**0.2**
Average	**0**	**11.1**	**9.1**	**0.3**	**1.6**

Appendix D Table 2. Historical use of out of basin strays in broodstock: 2007-2021.

Year	Total number of matings	Matings including Stray males [a]	Matings including Stray females	Number of matings containing stray x stray mating	% of total matings with stray parentage
2007	1,458	3	7	0	0.7%
2008	1,309	1	0	0	0.1%
2009	1,293	0	1	0	0.1%
2010	1,238	3	9	0	1.0%
2011	1,251	0	6	0	0.5%
2012	1,184	0	1	0	0.1%
2013	1,240	6	59	1	5.2%
2014	1,162	0	0	0	0.0%
2015	1,200	0	24	0	1.9%
2016	1,210	0	0	0	0.0%
2017	1,285	1	0	0	0.1%
2018	1,253	0	0	0	0.0%
2019	1,151	5	4	0	0.8%
2020	1,107	4	2	0	0.5%
2021	**1,216**	**3**	**8**	**0**	**0.9%**
Average	**1,237**	**1.7**	**8.1**	**0.07**	**0.01%**

[a] Males used multiple times are included multiple times.

Appendix E: Egg Take and Early Life Stage Survival Brood Years: 1990-2013

Appendix E Table 1: Egg take and survival numbers by life stage of LFH origin fall Chinook salmon spawned at LFH, brood years 2000-2013.

Brood year	Eggs taken	Egg loss [a]	Eggs destroyed [b]	Eggs shipped [c]	Eyed eggs retained	Fry ponded	Intended program
2000	3,576,956	53,176	0	115,891	3,249,377	998,768	Yearling
						2,159,921	Subyearling
2001	4,734,234	144,530	0	200,064	4,230,432	1,280,515	Yearling
						2,697,406	Subyearling
						125,600	Research
2002	4,910,467	44,900	0	1,195,067	3,540,000	1,032,205	Yearling
						2,376,251	Subyearling
						73,229	Research
2003	2,812,751	0	0	250,400	2,476,825	985,956	Yearling
						1,455,815	Subyearling
2004	4,625,638	0	0	1,053,278	3,421,751	914,594	Yearling
						2,191,102	Subyearling
						184,682	Research
2005	4,929,630	0	0	1,180,000	3,562,700[e]	980,940	Yearling
						2,078,206	Subyearling
						216,417	Research
2006	2,819,004	0	0	127,564	2,601,679	961,105	Yearling
						1,640,574	Subyearling
						2,000	Research
2007	5,143,459	0	0	1,761,500	3,212,900[f]	960,900	Yearling
						1,894,933	Subyearling
2008	5,010,224	0	0	1,810,800	2,969,200	1,000,000	Yearling
						1,969,200	Subyearling
2009	4,574,182	0	0	1,507,300	2,853,020	977,667	Yearling
						1,875,353	Subyearling
2010	4,619,533	124,433	0	1,630,000	2,865,100	980,000	Yearling
						1,885,100	Subyearling
2011	4,723,501	165,001	0	1,785,600	2,772,900	960,000	Yearling
						1,812,900	Subyearling
2012	4,526,108	141,608	0	1,480,000	2,904,500	1,010,000	Yearling
						1,894,000	Subyearling
2013	4,565,660	119,550	0	1,558,800	2,887,310	980,000	Yearling
						1,907,310	Subyearling

[a] Eggs from ELISA positive females were incorporated into the rest of the broodstock in 1997-1998 and 2003-2004.

[b] Eggs culled due to ELISA results, stray or stray mate, and jill or jack mate.

[c] Includes eyed eggs shipped for research.

[d] An overage of 58,500 fish were found during marking. This number was added (unexpanded) to total green and eyed eggs and fry ponded. Also includes 83,183 fry up to ponding that were accidentally released as strays. Back calculated to estimate 32,088 eggs for subyearlings and 91,808 eggs for escaped fry (resulting in 847,241 ponded for yearling release).

[e] This number includes 154,100 eyed-eggs that were destroyed as ponded fry and 30,000 eyed-eggs that were shipped as fry to NPTH in February 2006.

[f] This number includes 364,983 eyed-eggs that were destroyed as ponded fry in January and February 2007.

Appendix F: LFH/Snake River Origin Fall Chinook Salmon Releases in 2022

Appendix F Table 1: LFH/Snake River HOR fall Chinook releases with number marked, tagged, and unmarked by release year and type. [a]

Release year	S/Y [b]	Brood year	Release location-type	Release date	CWT code	AD clip +CWT	CWT only	AD clip only	No clip or CWT	Total Released	FPP	PIT Tagged
2022	Y	2020	Lyons Ferry Hatchery	22-Mar	637944	429,871	473	237		433,895	10.0	9,994
Total yearling releases						***429,871***	***473***	***237***		***433,895***		***10,000***
2022	S	2021	Lyons Ferry Hatchery	25-May	638056	203,311	1,067	356	312,427	517,161	46.1	14,999
2022	S	2021	Captain John 1st	12-May	220405	202,452	905	774	252,643	456,774	50.7	25,954
2022	S	2021	Big Canyon 1st	11-May	220407	202,886	907	775	253,647	458,215	58.3	11,079
2022	S	2021	Pittsburg Landing 1st	4-May	220403	202,322	904	774	206,393	410,393	51.0	25,958
2022	S	2021	Pittsburg Landing 2nd	25-May	220404	199,434	891	762	44	201,131	47.8	4,482
2022	S	2021	Big Canyon 2nd	1-Jun	220408	198,670	888	759	44	200,361	51.9	4,492
2022	S	2021	Captain John 2nd	2-Jun	220406	196,812	880	753	42	198,487	45.0	4,497
2022	S	2021	Grand Ronde River Direct	NA	NA					0	NA	0
2022	S	2021	NPTH-Site 1705-MF Clearwater R	14-Jun	220285	103,454	1221	746	563,365	668,786	66.8	4,466
2022	S	2021	NPTH-Lukes Gulch Accl.-SF Clearwater R	8-Jun	220288	102,956	580	243	178,173	281,952	55.2	4,500
2022	S	2021	Cedar Flats Acclimation	7-Jun	220287	101,653	937	179	145,025	247,794	64.1	4,473
2022	S	2021	North Lapwai Valley Acclimation	7-May	220286	104,081	673	293	178,976	284,023	100.0	4,494
2022	S	2021	Salmon River Direct Stream	19-May	092064	201,795	1,380	6,209	607,599	816,983	50.0	4,500
Total subyearling releases						***2,019,826***	***11,233***	***12,623***	***2,698,378***	***4,742,060***		***113,894***

[a] Numbers presented do not necessarily match hatchery records for fish per pound because of reporting constraints for the hatchery.

[b] S/Y indicates subyearling or yearling rearing strategy.

Appendix G: Tucannon River Survey Sections and Historical Escapement

Appendix G Table 1: Description and length of sections, survey length, percent of reach surveyed, and estimated total number of fall Chinook salmon redds in the Tucannon River, 2021.

Section	Description	Length of section (km)[a]	Length surveyed (km)	% of productive reach surveyed [b]	Estimated total # of redds [c]
1	Mouth of river to Highway 261 Bridge	1.7	1.7	100	19
2	Highway 261 Bridge to Smolt trap	0.15	0.15	100	3
3	Smolt trap to Powers Bridge	0.7	0.7	100	10
4	Powers Bridge to upper Hog Barns	1.45	1.45	100	18
5	Hog Barns to Starbuck Br.	2.4	2.1	87.5	38
6	Starbuck Br. To Fletchers Dam	2.7	1.4	51.9	25
7	Fletcher's Dam to Smith Hollow	3.0	3.0	100	10
8	Smith Hollow to Ducharme's Bridge.	4.6	4.6	100	3
9	Ducharme's Bridge to Highway 12	5.7	5.7	100	9
10	Highway 12 to Brines Road Bridge	6.2	6.2	100	0
11	Brines Road Bridge to King Grade	4.7	4.7	100	0
	Total	**33.3**	**31.7**	**95.2**	**354**

[a] Section lengths were measured using Google Earth Pro.
[b] Percentage is based upon length of stream that is presumed to successfully produce fry.
[c] Counted redds were expanded based on percent of reach surveyed to estimate total number of redds.

Appendix G Table 2: Estimated escapement, % stray component of the run, and number of redds (observed and estimated) in the Tucannon River, 1985-2000.

Year	Estimated escapement [a]	# Redds observed	# Redds in no access areas (estimate)	Total # of Redds (estimate)
1985 [b]	0	0	No estimate	0
1986 [c]	2 [d]	0	No estimate	0
1987	48	16	0	16
1988	78	26	0	26
1989	150	48	2	50
1990	186	62 [e]	0	62
1991	150	50	0	50
1992	69	23	0	23
1993	84	28	0	28
1994	75	25	0	25
1995	87	29	0	29
1996	144	43	5	48
1997	93	27	4	31
1998	132	40	4	44
1999	87	21	8	29
2000	60	19	1	20

Appendix H: 2022 Snake River Fall Chinook Hatchery Salmon Yearling to Subyearling Conversion for Production at Lyons Ferry Hatchery

"White Paper"

Snake River Fall Chinook Hatchery Salmon

Yearling to Subyearling Conversion for Production at Lyons Ferry Hatchery

White Paper

Joe Bumgarner, Washington Department of Fish and Wildlife
William Young, Nez Perce Tribe
Stuart Rosenberger, Idaho Power Company

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Executive Summary

Hydrosystem mitigation in the form of hatchery production is an integral part of current Snake River fall Chinook Salmon (SRFCH) co-management efforts. Multi-agency monitoring and evaluation efforts in the Snake River Basin are in place to generate information critical for future regional Endangered Species Act (ESA) recovery efforts, harvest planning, hatchery production, and fisheries management. Current SRFCH hatchery production, release sites, prioritization of production, marking, tagging, and egg distributions are directed by the *2018-2027 U.S. vs Oregon Management Agreement* (Agreement). Table B.4 (Snake River Fall Chinook Salmon) of the Agreement contains the following provision: 'The Parties agree during the term of the Agreement to re-evaluate and discuss the reduction and/or substitution of the yearling program at Lyons Ferry Hatchery (LFH) to subyearlings.' This document is meant to inform those discussions and decisions.

The Snake River Basin managers expressed three management objectives where no net loss in adult (including jacks) production measured by average returns would be noticeable in a) coastwide returns (to address harvest objectives in the ocean or Columbia River fisheries, b) to the Lower Snake River compensation area (to address Lower Snake River Compensation Plan (LSRCP) mitigation goals, or c) upstream of Lower Granite Dam (to address multi-agency harvest and supplementation objectives). This report compares overall yearling to subyearling 1) overall adult run timing, 2) smolt-to-adult returns (SAR) and smolt-to-adult survivals (SAS), 3) a range of subyearling hatchery production estimates that would be required to replace adults produced from the yearling releases based on the current proposal, 4) age at return and size composition of returning adults, 5) general contributions of SRFCH to ocean harvest, and 6) specific contributions to three defined Columbia River fisheries. The results of our analysis are as follows:

- The yearling production at LFH was retained to provide a "safety net" for broodstock purposes, but their current use has been minimized by increased returns from subyearling production.

- Average run timing of adult SRFCH at Bonneville Dam returning from yearling and subyearlings releases are nearly identical and overlap completely with the fall Chinook fisheries below (Zones 1-5) and above (Zone 6) Bonneville Dam.

- At the SAS level, yearlings released at LFH out-perform subyearlings released at LFH (2.4 – 2.9 times better depending on the calculation method and time interval used). Based on these estimated conversion rates, a range of 1.3 to 1.6 million additional subyearlings (beyond the current hatchery subyearling production) would have to be produced to equally replace adult returns from the current release of 450,000 yearlings.

- Yearlings produce mini-jacks[1] (25-55 cm in length) while subyearlings do not produce mini-jacks. Subyearlings produce more older (3-, 4-, and 5-salt) returning adults compared to yearling releases. Over the last 20 years, 1-salt and 2-salt yearlings are on average larger in size compared to subyearlings; however, the size differences don't exist in the older age classes. Further, size at age

[1] Mini-jacks remain in fresh water or have a short estuary phase, then head back upstream a few months later to reproduce at age 2.

distributions has changed over the last 20 years, with 2-salt and 3-salt yearlings and subyearlings essentially equating to the same size, which was not the case prior to 2010.

- The overall contributions of SRCFH adults from yearling and subyearling releases in fisheries (ocean and freshwater) are similar, though in the ocean, yearlings have a slightly higher contribution off the coast of Washington than subyearlings, and subyearlings appear more in Alaska fisheries than yearlings.

- Using retrospective analysis, we demonstrated that the hypothetical additional subyearling production equaled or slightly increased the overall harvest in the three main Columbia River fisheries (below Bonneville Net, below Bonneville sport, and Zone 6 net). From a yield (poundage) standpoint, subyearlings will likely produce an overall increase in the number of pounds taken from these fisheries in the future.

Background

Hydrosystem mitigation in the form of hatchery production is an integral part of SRFCH management, with multiple State, Tribal, Federal, and non-governmental agencies involved. A highly coordinated, multi-agency monitoring and evaluation effort is in place to generate information critical for future regional recovery planning, hatchery production, harvest planning and management. Since being listed as threatened under the Endangered Species Act (ESA) in 1992 SRFCH returning to the Snake River Basin have increased from less than a thousand fish in the 1990's to over seventy-five thousand fish in 2013 (Figure 1). The increased abundance of SRFCH was achieved in large part by using a hatchery program consisting of diverse release locations and rearing strategies including both yearling and subyearling juvenile life history forms. Hatchery releases began downstream of Lower Granite Dam at Washington Department of Fish and Wildlife's (WDFW) Lyons Ferry Hatchery (LFH) in 1984 under the Lower Snake River Compensation Plan (LSRCP) mitigation program (USCOE 1975) and expanded in the mid-1990's to include releases upstream of Lower Granite Dam from the Nez Perce Tribe's Fall Chinook Acclimation Program (FCAP), in addition to an Idaho Power Company (IPC) hatchery program in 2001, and most recently, the development of the Nez Perce Tribe Hatchery (NPTH) Complex in 2003. Current SRFCH hatchery production, release sites, marking, tagging, and egg distributions are directed by the *2018-2027 U.S. vs Oregon Management Agreement* (Agreement). Production Table B.4 within the Agreement, not only identifies and lists release sites and strategies, but also prioritizes the hatchery programs, should egg collections fall short of that needed for the entire Snake River Basin hatchery program (Appendix A, Table A1).

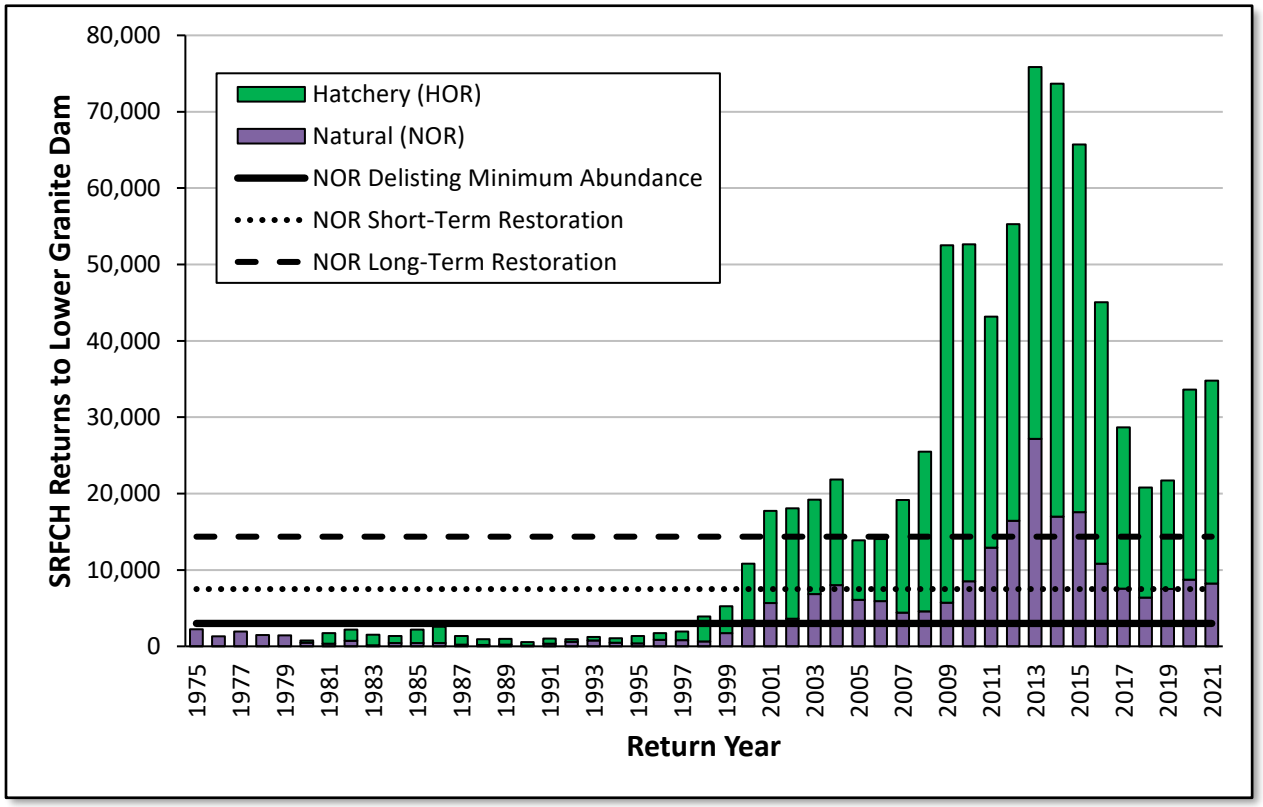


Figure 1. Estimated returns of hatchery and natural Snake River fall Chinook Salmon to Lower Granite Dam (1975 – 2021).

In 2017, an analysis was developed to inform decisions regarding changes to SRFCH production, release locations, and life history types (yearling and subyearlings) for the new 2018-2027 Agreement. A major outcome of that analysis and subsequent discussion was the conversion of 450,000 yearlings released above Lower Granite Dam from the Fall Chinook Acclimation Project (FCAP) to subyearling production. While all 900,000 yearling production was considered for conversion at the time, the group of 450,000 released at LFH were retained as a safety net for the program for potential future broodstock needs because of an anticipated period of poor ocean conditions and reduced survival. The potential to convert the remaining yearlings at LFH at some point in the future was captured in a footnote to Table B.4 (Snake River Fall Chinook Salmon) of the Agreement: 'The Parties agree during the term of the Agreement to re-evaluate and discuss the reduction and/or substitution of the yearling program at LFH to subyearlings.'

This document and subsequent analysis are provided as an update to make informed decisions about a ***DRAFT*** proposal to convert the current production and release of yearlings to subyearlings at LFH and additional subyearling releases at other sites upstream of Lower Granite Dam.

Justification to Convert Yearlings to Subyearlings

The dominant life-history form of SRFCH natural origin juveniles are subyearlings (NOAA Fisheries ESA Recovery Plan for Snake River Fall Chinook - November 2017). At LFH, the original hatchery production plan for the LSRCP program was to produce 9 million subyearlings. However, it was recognized early in the program that yearlings also needed to be produced (Figure 2) because of their greater survival advantage (Bugert et al. 1997), which helped build the program to a sustainable brood level. However, beginning around 2006, the yearling survival advantage narrowed, and along with stable contribution of adults from subyearling releases, was a deciding factor for eventually transitioning the FCAP yearling program to subyearlings beginning with Brood Year (BY) 2018. Yearlings currently make up ~8% of the overall SRFCH hatchery juvenile production (Figure 2). Better performance from subyearling production, and a purposeful shift toward spawning older and larger adults in broodstock (Milks and Oakerman, 2018) has led to less reliance from yearling production, particularly for broodstock, in recent years. However, the yearling percentage of the overall fall Chinook salmon collected at Lower Granite Dam is typically higher (Figure 3) demonstrating that they are mostly being collected to satisfy SRFCH run-reconstruction coded-wire tag (CWT) data needs.

Yearling fall Chinook consistently produce more mini-jacks (only observed from yearling releases) and jacks compared to subyearling releases (Figures 4 and 5, respectively). Currently, mini-jacks and nearly all yearling and subyearling-origin jacks are not utilized for broodstock but are collected for run-reconstruction purposes. Generally, jacks (either life history origin) are only used sparingly during the spawning season or if there is a shortage of older, larger males. Some mini-jacks and jacks contribute to harvest, and jacks are counted towards the LSRCP adult mitigation goals. As such, jacks cannot be discounted, and were therefore included in the analysis. For releases of yearlings and subyearlings at LFH from brood years 2002-2017, yearlings returned 32% mini-jacks, 24% jacks, and 44% adults on average, while subyearlings returned no mini-jacks, 32% jacks, and 68% adults (Figures 4 and 5). Returning age composition from other SRFCH releases of yearlings and subyearlings from the FCAP program above Lower Granite Dam are similar to Figures 4 and 5.

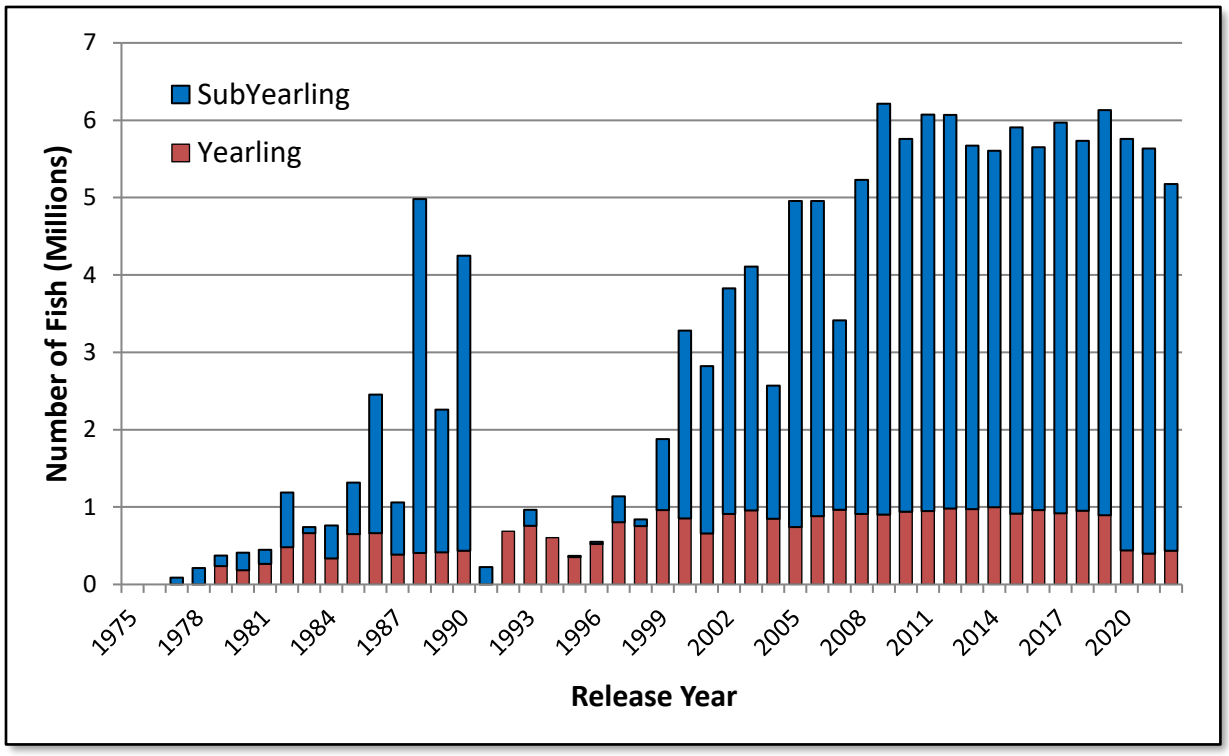


Figure 2. Juvenile releases of Snake River fall Chinook Salmon (yearling or subyearling) in the Snake River Basin (1977 – 2021).

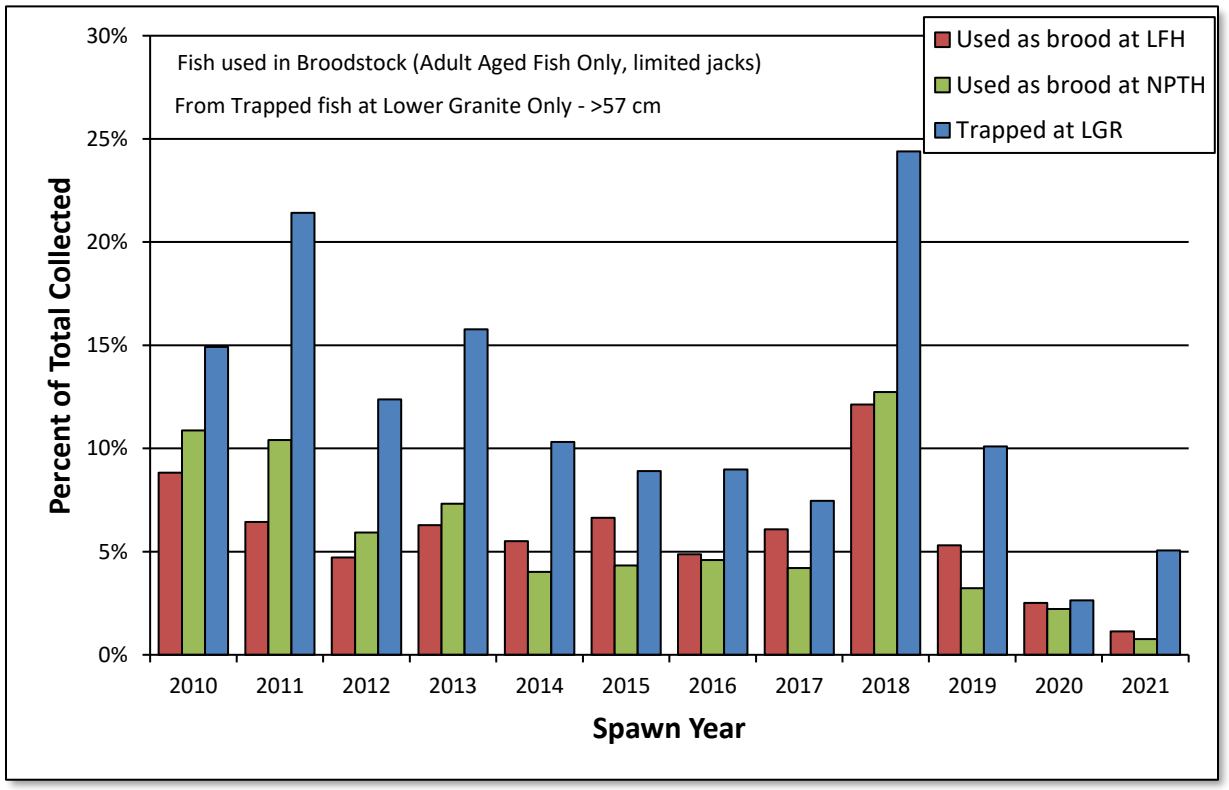
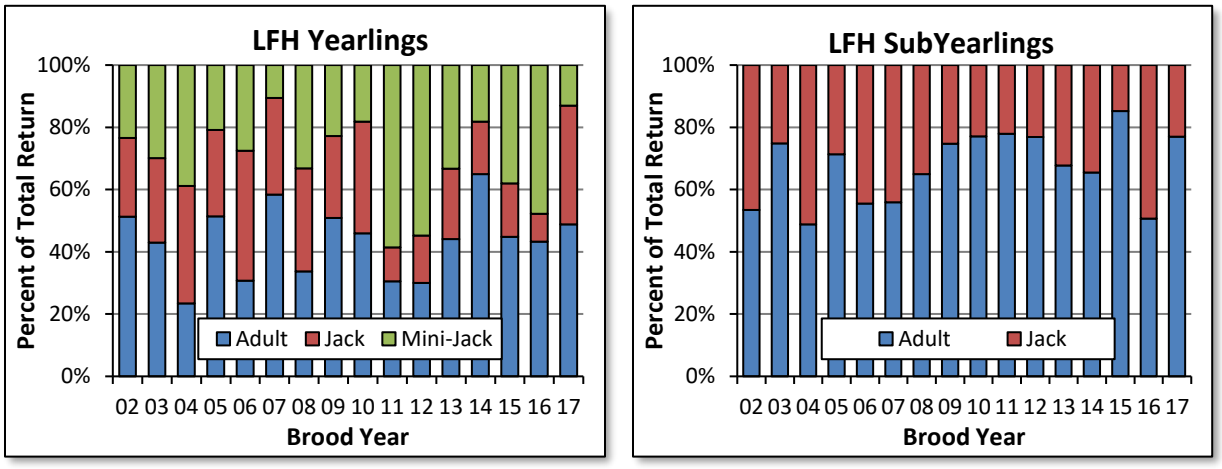


Figure 3. Lyons Ferry released yearling fall Chinook and their proportion of broodstock collections at Lower Granite Dam, and their actual use as broodstock at Lyons Ferry or Nez Perce Tribal Hatcheries (2010 – 2021).



Figures 4 and 5. Age composition of returning mini-jacks, jacks, and adults from yearling and subyearling fall Chinook released at Lyons Ferry Hatchery (BY 2002-2017). Estimates are from recoveries from all locations.

NOAA Fisheries identified in the Recovery Plan that the hatchery production of "yearlings was under review and may be discontinued". A conversion of remaining artificially produced SRFCH yearlings to subyearlings would address this point. However, the continued release of yearling hatchery production was not the only risk identified in the SRFCH Recovery Plan, and for the "safety net" reasons stated above, the continued production of yearlings at LFH was a risk reduction/management decision by the co-managers at the time. This co-management decision was approved and authorized by NOAA Fisheries.

Finally, with the conversion of yearlings to subyearlings, useable rearing space at both Lyons Ferry and Irrigon fish hatcheries would change. In addition, there will be changes in broodstock requirements for the program, costs (rearing/marking/tagging), and fish transportation logistics. Once a final production plan is accepted and approved by the managers for SRFCH production, the remaining available rearing space could be redefined and allocated to benefit the overall performance of the LSRCP program. A potential outcome of interest to the LSRCP would be in the form of additional releases of spring Chinook – a LSRCP program that has not met expectations.

Objectives

The Snake River Basin managers expressed three management objectives where no net loss in adult (including jacks) production measured by average returns would be noticeable in a) coastwide returns (to address harvest objectives in the ocean or Columbia River fisheries, b) to the Lower Snake River compensation area (to address Lower Snake River Compensation Plan (LSRCP) mitigation goals, or c) upstream of Lower Granite Dam (to address multi-agency harvest and supplementation objectives).

This analysis will compare:

1) Return timing at Bonneville Dam between yearling and subyearling releases from the SRFCH program in relation to downriver fisheries timing.
2) Performance (smolt-to-adult return (SAR) and smolt-to-adult survival (SAS)) of yearling and subyearling releases at LFH to determine the appropriate conversion rate of yearling to subyearling production to meet management and mitigation objectives.

3) Age and size composition of adult returns between yearling and subyearling life histories (data from all SRFCH release groups).
4) Contributions to harvest of LFH yearlings in Columbia River fisheries with extrapolated replacement from subyearling production as currently proposed by release site.

Together these sets of metrics provide information that is critical for future hatchery production and management, meeting U.S. vs. Oregon Management Agreement commitments, regional ESA recovery planning, harvest planning and management, and mitigation.

Methods

To present the data in a comparable and consistent manner, a series of definitions/criteria were developed to promote the greatest amount of utility when comparing and contrasting the different survival estimates from releases at LFH, retuning age compositions, contributions to harvest, and overall run timing. These definitions/criteria include:

1. Passage timing graphs at Bonneville Dam incorporate all PIT tags associated with any SRFCH hatchery release, regardless of mark type. Years provided represent 2011-2021 returns years.
2. To accurately evaluate survival differences between yearling and subyearling releases at LFH, release years, rather than brood years, were compared in the analyses. Release year was used because the groups would experience similar migration and ocean conditions. Conditions would be vastly different if brood years were analyzed against each other.
3. Jack and adult survival calculations were based on ocean age, not fork length. Jacks are defined as one-ocean age fish regardless of age at release (subyearling or yearling). Minijack (0 ocean) returns were not included in any analysis since they do not count towards the LSRCP mitigation goals. However, as demonstrated previously (Figure 4), they can comprise a substantial proportion of returns from the LFH released yearlings.
4. Summarized SAS and SAR from LFH releases (yearling and subyearling) from the 2001 to 2019 release years were analyzed. Using the NOAA Stoplight Chart for Ocean Indicators (Appendix B, Figure B1, https://www.fisheries.noaa.gov/content/ocean-conditions-indicators-trends), survival data were grouped into periods of good or bad ocean conditions, with an additional split made for pre/post summer spill period (2006 migration year). Regression plots of subyearling versus yearling survivals were created for jacks only, adults only, and adult and jacks combined, and are presented in Appendix B, Figures B2-B7. The purpose of this analysis was to examine the slopes of the regression lines and see if changes in ocean conditions or the pre/post summer spill period changed the conversion rates between yearlings and subyearlings. Based on the results of that analysis (Pre-summer spill showed differences in the slopes), it was decided to estimate the subyearling to yearling conversion based on the time series of releases from 2006-2019.
5. Summarized SAS and SAR from LFH releases (yearling and subyearling) from the 2006-2019 release years are provided as 1) a pooled average, 2) the mean of all years, and 3) the geomean of all years. Release years 2018 and 2019 are incomplete due to 1) a lag in harvest reporting to the Regional Mark Information System (RMIS), or 2) returns of 3- or 4-salt fish that may return in the future.
6. To extend the data set to include as many release years as possible, sibling regressions were preformed to estimate future returns for release years 2018 and 2019. Due to the nature in uncertainty for the sibling regressions, we provided the same “what is needed for additional production of subyearlings?” based on release years 2006-2017, or 2006-2018 for comparison.
7. All SAS and SAR comparisons and harvest data were between groups that have both an Adipose Clip and a Coded Wire Tag (AD/CWT). Adult returns were estimated using expanded CWT recoveries

based on the hatchery tag rate, and harvested fish were expanded by fishery recovery rate (reported in RMIS), and further expanded by the hatchery tag rate. Harvest data provided incorporates all gears and types whether in the ocean or in the Columbia River. Specific sections provided below regarding harvest of SRFCH will be defined further as needed.

8. We used a conversion formula found in Conrad and Guttman (1996) to convert fork length to total length. Fish lengths reported in RMIS are by total length. We then used a length to weight conversion chart (https://www.in-fisherman.com/editorial/chinook-salmon-weight-conversion-chart/154538) for Chinook salmon to estimate the weight of those fish captured in fisheries based on the reported length.
9. While not necessarily needed for any specific analysis, we provide catch timing curves of SRFCH from yearling and subyearling releases (all SRFCH release groups) as reported captured in specific fisheries from 2008-2020, with mean fishery open and close dates overlayed on the catch timing graphs. These are all provided in Appendix F for reference.

Methods and calculations specific to each metric are discussed in the results section of this report. Where appropriate, or for additional clarity, additional tables and/or figures can be found in the Appendices. For the following analyses, multiple data sources were used and include data downloaded from the Pacific States Marine Fisheries Commission (PSMFC) PTAGIS and RMIS databases, as well the annual multi-agency SRFCH Lower Granite Dam Run Reconstruction estimates.

Results

Bonneville Dam Run Timing Comparisons

Average run timing of adult SRFCH at Bonneville Dam returning from yearling and subyearlings releases are nearly identical and overlap completely with the fall Chinook fisheries below (Zone 1-5) and above (Zone 6) Bonneville Dam. A comparison of SRFCH average run timing at Bonneville Dam for return years 2011 - 2021[2] from yearling and subyearling releases are displayed in Figure 6 (adults) and Figure 7 (jacks). On average, returns from subyearling releases tend to cross Bonneville Dam slightly earlier than yearling releases, but by only a couple of days. Average Columbia River Net (Tribal and Non-Tribal) fishing seasons are provided to show the overlap with the average run timing.

[2] Individual run year timing at Bonneville Dam for yearling and subyearling adults and jacks are provided in Appendix C, Figures C1-C4 for reference, and show the variability in run timing that can occur.

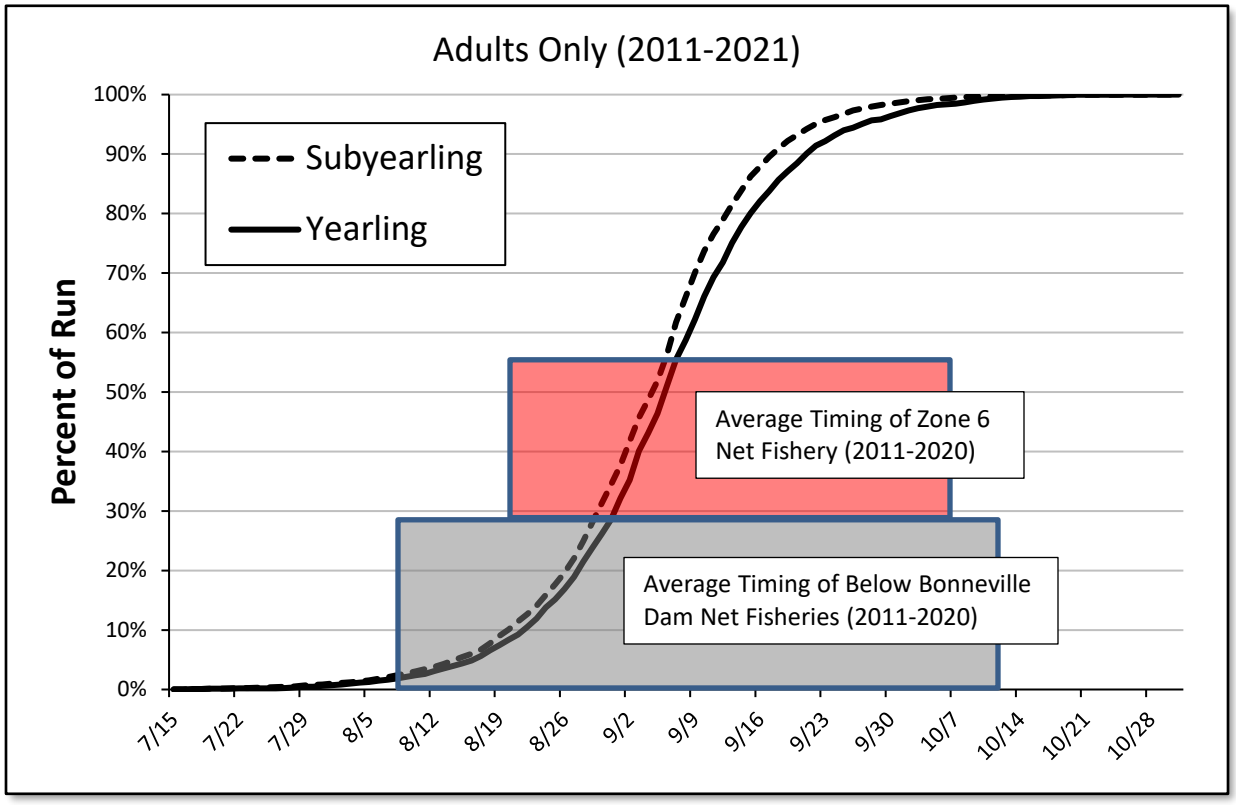


Figure 6. Average run timing of Snake River Fall Chinook Salmon yearling or subyearling adults (all SRFCH release groups combined) based on PIT tag detections at Bonneville Dam (2011-2021 return years).

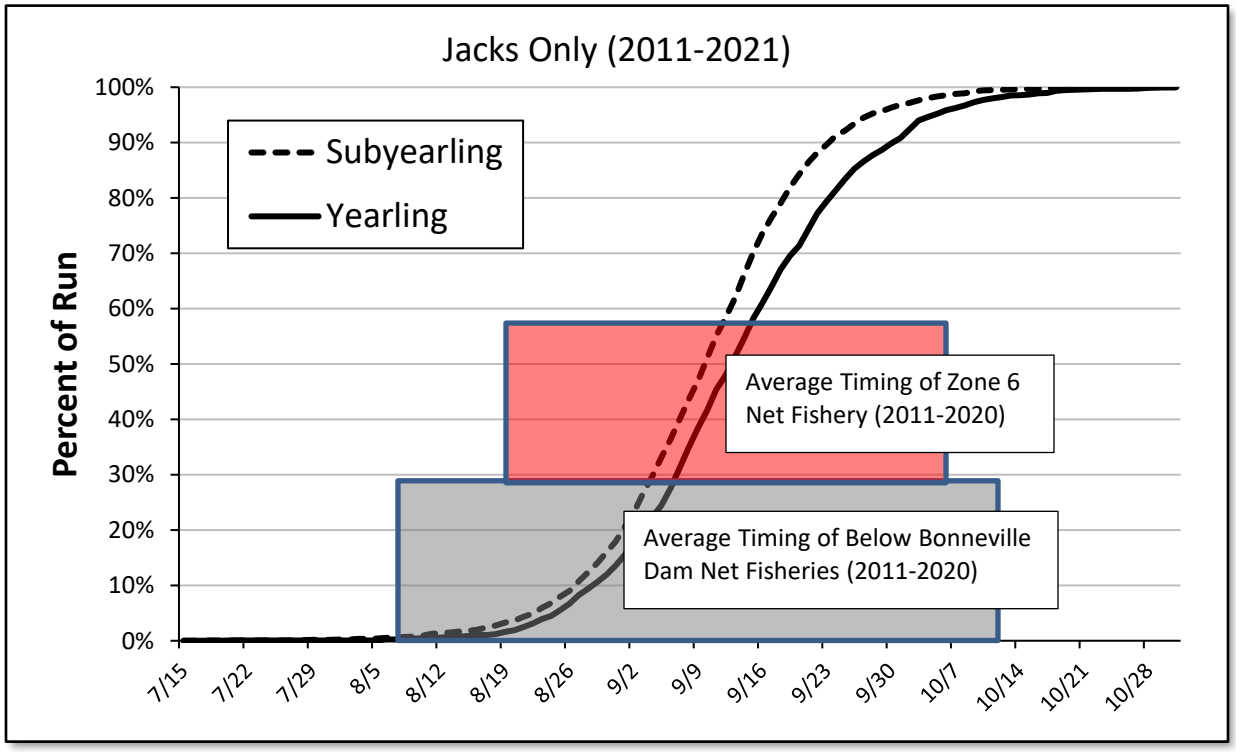
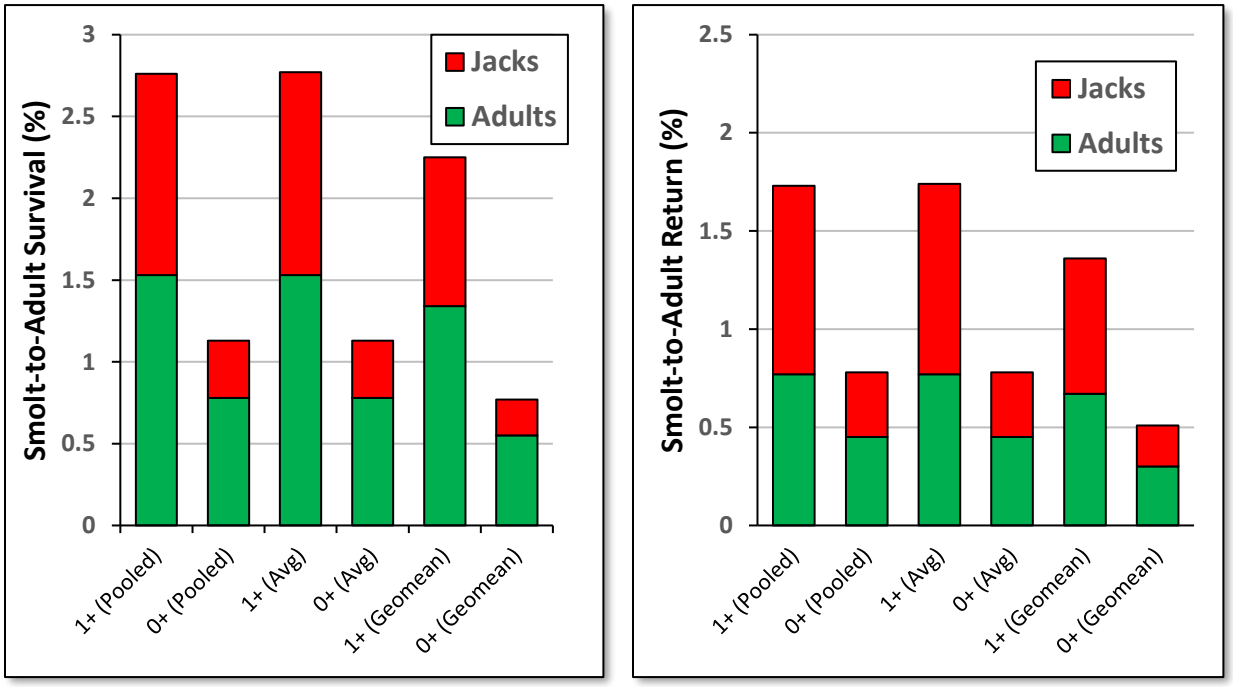


Figure 7. Average run timing of Snake River Fall Chinook Salmon yearling or subyearling jacks (all SRFCH release groups combined) based on PIT tag detections at Bonneville Dam (2011-2021 return years).

Smolt-to-Adult Survival (SAS[3]) and Smolt-to-Adult Return (SAR[4]) Rates

Yearlings released at LFH out-perform subyearlings released from LFH in both SAS and SAR survival estimates (2.2 – 2.9 times better) depending on calculation method, time interval used, and which survival rate was being compared (Figure 8 or Figure 9; Appendix D, Table D1). The SAS estimate accounts for all adult and jack contributions including harvest in the ocean and Columbia River, estimated returns to the Snake River, and all other recovery locations. The SAR estimate is measured at Ice Harbor Dam using Lower Granite Dam Run Reconstruction estimates combined with a PIT tag conversion correction factor since not all LFH releases return to Lower Granite Dam.



Figures 8 and 9. Average SAS or SAR (Pooled Average, Average, and Geomean) of returning adults and jacks from Snake River fall Chinook Salmon hatchery yearling (1+) and subyearling (0+) release groups at Lyons Ferry Hatchery (Release Years 2006-2017).

Hatchery Subyearling Production Needed for Replacement Objectives

Given differences between survival advantage in yearling over subyearling releases from 2006-2017, we estimated how much additional subyearling production would be needed to equal no net loss in overall returns, returns to the Snake River, and returns above Lower Granite Dam (Table 1). Approximately 1.1 million subyearlings (in addition to the current 700,000 subyearlings released at LFH) would have to be released ***at LFH*** to equal yearling returns. Due to rearing space limitations and other Snake River programs reared at the hatchery, LFH can only rear/release an additional 500,000 subyearlings under

[3] SAS = (Total number of AD/CWT fish recovered in harvest and other locations outside the Snake River Basin + AD/CWT fish estimated at Lower Granite Dam + the estimated number of these fish that remain between Ice Harbor Dam and Lower Granite Dam based on PIT tag conversions **/** Total number of AD/CWT fish released) x 100.

[4] SAR = (Total number of AD/CWT fish estimated at Lower Granite Dam + the estimated number of these fish that remain between Ice Harbor Dam and Lower Granite Dam based on PIT tag conversions) **/** (Total number of AD/CWT fish released) x 100.

current production scenarios. Therefore, a minimum of 600,000 subyearlings would have to be reared elsewhere to meet the total 1.1 million target. Subyearlings reared at a different facility would be released at sites above Lower Granite Dam which further support harvest and supplementation priorities for the program in the Snake River. Previous analysis of SASs/SARs from SRFCH program (Rosenberger et al. 2017) demonstrated that survival of subyearling releases above Lower Granite Dam were lower than subyearlings released from LFH. Due to this lower overall survival, additional subyearlings (>600,000) will therefore have to be produced to equalize the returns of the LFH yearlings (Table 1).

Release locations upstream of Lower Grantie Dam proposed and considered for additional subyearling releases in this analysis include 1) the Big Canyon Acclimation Site[5] on the Clearwater River (FCAP program) – as part of the second release of subyearlings, 2) Big Canyon Acclimation site[6] on the Wallowa River, tributary to Grande Ronde River, and 3) a non-acclimated direct stream release at Couse Creek in the Snake River[7]. These release locations and their estimated performance were used to predict expected outcomes.

Adult return performance (SAS and SAR) of these releases were summarized in identical fashion as the LFH on-station releases (Appendix D, Table D2). For predicting the additional subyearling production needed, sites with current available infrastructure and rearing capabilities were allotted first, with production at Couse Creek used to make any difference still needed to equalize the returns of the yearlings (Table 1). In addition, a few assumptions regarding the Grande Ronde and Couse Creek survivals utilized for this analysis need to be acknowledged.

Grande Ronde Release

- Releases of subyearling fall Chinook in the Grande Ronde River have been a direct stream release at the mouth of Cougar Creek[8] (lower Grande Ronde below the WA/OR border). The new proposed release moves these fish upstream by ~60 river miles. Survivals of subyearling fall Chinook from the ODFW Big Canyon Acclimation site are unknown at this time. For this analysis we assumed that they will be equal to previous releases.
- Survival data was not available for the 2007 release year as no releases occurred. Estimated SAS and SAR survival for the 2007 release year was derived from a regression model with LFH on-station subyearling releases.

Couse Creek Release

- Survival data was not available for the 2007 release year, or after 2013. Estimated SAS and SAR survival for missing years were again derived using a regression model with LFH on-station subyearling releases.

Based on the calculations provided (Table 1), a range of 1,378,000-1,615,000 additional subyearlings would be required to equalize the returns from the current release of yearlings (at the SAS level). Identical tables using 2006-2018 or 2006-2019 survivals, respectively (Appendix D, Table D3 or Table D4) estimate a range of 1,347,000-1,442,000, or 1,269,500-1,371,500, respectively.

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[5] Priority #7 – Table B.4 *U.S. vs. Oregon* Management Agreement.

[6] Not currently included in Table B.4 but facility is a Lower Snake River Compensation Plan acclimation site operated Oregon Dept. of Fish and Wildlife (ODFW) for steelhead on the Wallowa River.

[7] Not currently in Table B.4, but a historical release site for the program previously included in *U.S. vs. Oregon* Management Agreement.

[8] Priority #10 - Table B.4 *U.S.* vs. *Oregon* Management Agreement

Table 1. Estimated additional production of subyearling fall Chinook (at various locations) to replace the current releases of yearlings at Lyons Ferry Hatchery (2006-2017 Release Years).

Release Group	Current Production	Additional Subyearling Production	Total Subyearling Production	SAS (%)	SAS Returns	SAR (%)	SAR Returns	AG [a] (%)	AG Returns
Pooled Survival Estimates (2006-2017 Release Years)									
LFH 1+	450,000			2.76%	12,420	1.73%	7,785	0.35%	1,566
LFH 0+	700,000	1,099,000 [b]		1.13%	12,419	0.78%	8,572	0.31%	3,429
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	1.13%	5,650	0.78%	3,900	0.31%	1,560
GRR 0+	200,000	300,000	500,000	0.52%	1,560	0.30%	900	0.29%	873
BC 0+ 2nd Rel	200,000	200,000	400,000	0.96%	1,920	0.60%	1,200	0.58%	1,164
CCR 0+	0	378,000	378,000	0.87%	3,289	0.55%	2,079	0.53%	2,017
Totals					12,419		8,079		5,614
Gains/Losses	***-450,000 (1+)***	***1,378,000 (0+)***			***- 1***		***+ 294***		***+ 4,057***
Mean Survival Estimates (2006-2017 Release Years)									
LFH 1+	450,000			2.76%	12,432	1.74%	7,829	0.30%	1,364
LFH 0	700,000	1,105,500 [b]		1.12%	12,432	0.78%	8,627	0.31%	3,451
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	1.12%	5,623	0.78%	3,902	0.31%	1,561
GRR 0+	200,000	300,000	500,000	0.52%	1,568	0.30%	886	0.29%	859
BC 0+	200,000	200,000	400,000	1.02%	2,034	0.60%	1,209	0.59%	1,173
CCR 0+	0	385,000	385,000	0.83%	3,207	0.53%	2,054	0.52%	1,993
Totals					12,432		8,051		5,586
Gains/Losses	***-450,000 (1+)***	***1,385,000 (0+)***			***+ 0***		***+ 222***		***+ 4,020***
Geomean Survival Estimates (2006-2017 Release Years)									
LFH 1+	450,000			2.25%	10,144	1.36%	6,134	0.27%	1,227
LFH 0	700,000	1,132,000 [b]		0.77%	10,142	0.51%	6,744	0.20%	2,698
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	0.77%	3,842	0.51%	2,554	0.20%	1,022
GRR 0+	200,000	300,000	500,000	0.36%	1,075	0.18%	547	0.18%	531
BC 0+	200,000	200,000	400,000	0.72%	1,436	0.39%	780	0.38%	757
CCR 0+	0	615,000	615,000	0.62%	3,787	0.35%	2,150	0.34%	2,085
Totals					10,140		6,031		4,394
Gains/Losses	***-450,000 (1+)***	***1,615,000 (0+)***			***- 4***		***- 103***		***+ 3,168***

[a] AG = Above Lower Granite Dam. Based on the Radio Telemetry Study conducted from 2013-2017 (Cleary et al.), and from PIT Tag Conversions from Ice Harbor to Lower Granite, approximately 20% of the yearlings from LFH, 40% of the subyearlings from LFH, and 97% of the other releases above Lower Granite are estimated to return to and stay above Lower Granite on an annual basis.

[b] This is the number of LFH released subyearlings it would take to replace the 450,000 yearlings. Since LFH can only release another 500,000 on top of current production (700,000), then the additional production must occur elsewhere.

Size and Age at Return

Age at return between yearling and subyearling releases, as previously shown (Figures 4 and 5), is an important metric to consider. Along with different age composition, size at age between yearling and subyearling releases are also different (Figure 10, Appendix E - Figures E1-E4) in some age classes. While not statistically different, the median and mean size of subyearlings at the 1-salt or 2-salt age classes are smaller than those released as yearlings (Figure 10). However, the size difference is not apparent in the 3-salt or 4-salt age classes. The size differences at individual age classes have also varied over time (Appendix E – Figures E1-E4). The relative size difference between yearling and subyearling jacks has remained relatively constant between 2000-2020, though there was a period from 2004 to 2011 where the size of yearling jacks increased (Appendix E, Figure E1), but the same pattern is not as apparent for the subyearlings. For 2-salt aged fish, yearlings are consistently larger than subyearlings, but the relative difference has diminished over time (Appendix E, Figure E2), as yearling released SRFCH have gotten smaller in size since about 2013. The size of subyearling 3-salt fish has remained relatively consistent over time, while the yearlings used to be larger in size until about 2011, and from that point forward they are nearly identical in size (Appendix E, Figure E3). These size differences, and how they relate to overall harvest, must be considered, and will be further examined in the harvest section below.

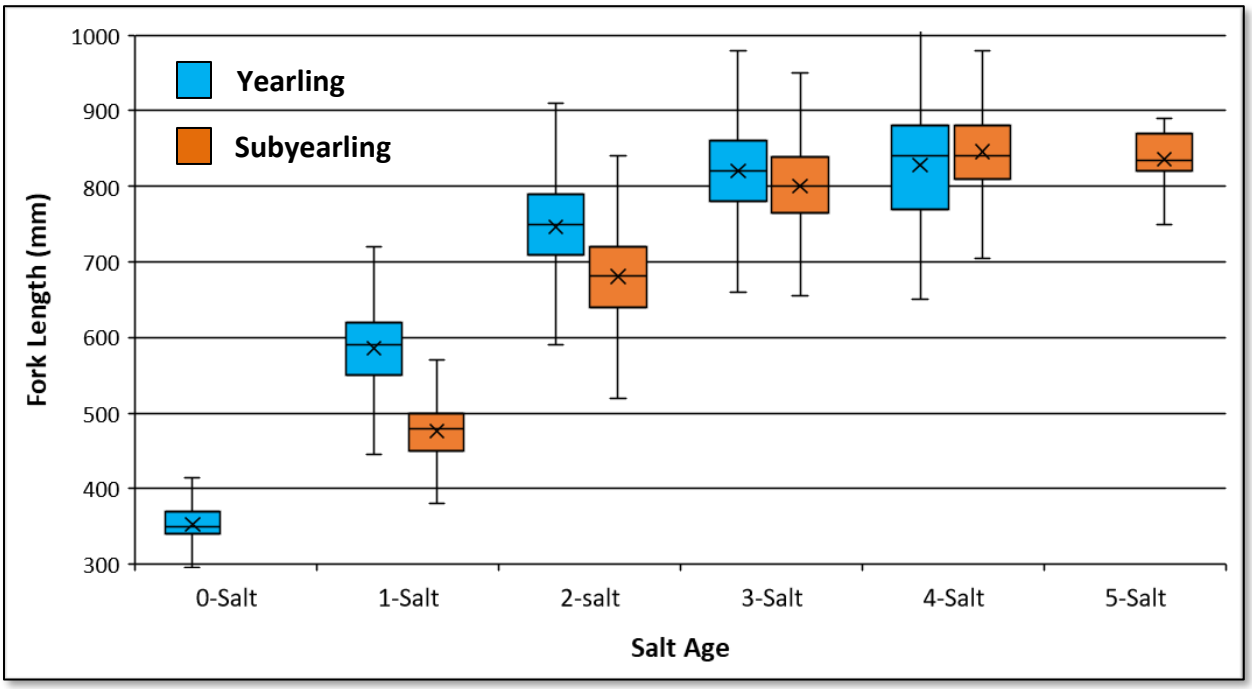
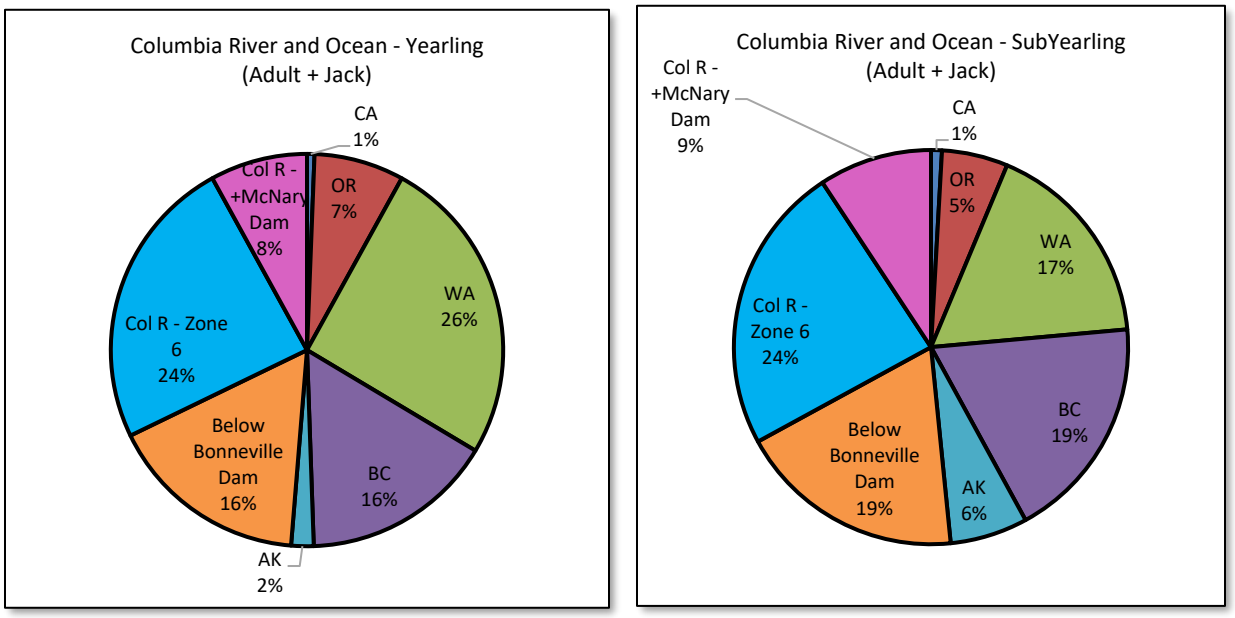


Figure 10. Box-Whisker plots showing size at age distribution for Snake River fall Chinook Salmon yearlings and subyearlings, return years 1998-2021, N=107,417 individual fish. The horizontal line inside the box represents the median, and "x" in the box represents the mean. Recoveries are inclusive of all SRFCH releases in the Snake River Basin from all programs.

Harvest

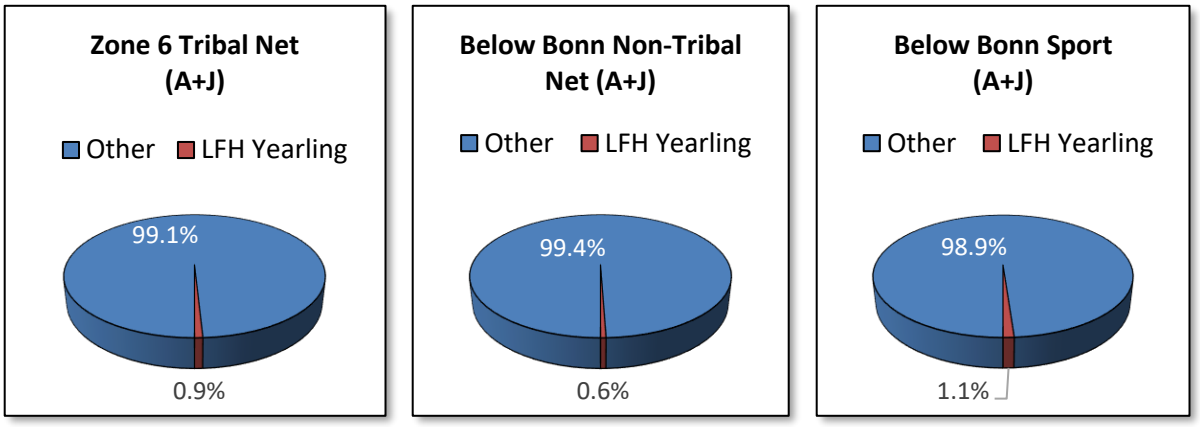
Harvest has always been a major objective of the SRFCH program. Overall contributions in the Pacific Ocean and Columbia River Fisheries (both commercial and sport) combined can reach 50% of the total adults produced. As such, making sure that changing the LFH yearling production to subyearlings will not influence future harvest levels needed to be further explored.

Overall, distributions of harvest are similar between yearling and subyearling SRFCH releases, but there are some subtle differences (Figures 11 and 12). Based on the data it appears that the yearlings are harvested locally in the ocean (Oregon, Washington, and British Columbia) as compared to the subyearlings. This is most likely because of the younger age at return of yearlings. Within Columbia River fisheries, harvest contributions between yearling and subyearlings are nearly identical (Figures 11 and 12).



Figures 11 and 12. Ocean and Columbia River harvest distributions of Snake River Fall Chinook Salmon yearlings and subyearlings (all Snake River Basin release groups combined), 2006-2017 release years.

As shown in Figure 11, harvest distribution of yearling SRFCH in the Columbia River below Bonneville (Zone 1-5 commercial or sport fisheries) and above Bonneville (Zone 6 fishery) accounts for approximately 40% of the total harvest from all locations. Since a large percent of the yearling harvest occurs in these areas, a closer look at the actual contribution of LFH released yearlings was needed for each fishery. Total harvest of fall Chinook in the Zone 6 Tribal Net fishery, the below Bonneville Non-Tribal Net fishery, and the below Bonneville sport fishery from 2008-2020 return years were obtained from the WDFW/ODFW Joint Staff Reports (*Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead and White Sturgeon: Joint Columbia River Management Staff (2008-2020 Run Year Reports).* We then used the RMIS CWT database to query LFH released yearlings captured in those fisheries (estimated CWTs expanded by the fishery sample rate, with that number then expanded by the tag rate at release) to determine the annual and average contribution of LFH released yearlings into each of these major fisheries (Figures 13-15). On average, LFH released yearlings contribute between 0.6%-1.1% into those fisheries (Figures 13-15).



Figures 13-15. Average contribution of Lyons Ferry Hatchery released yearling Snake River Fall Chinook Salmon into the Zone 6 Tribal Net fishery (13), the below Bonneville Dam Non-Tribal Net fishery (14), or the below Bonneville Dam Sport fishery (15).

One of the primary objectives considered in any proposal to change SRFCH hatchery production from yearlings to subyearlings was to not have any negative effects on fisheries. To evaluate that, we conducted a retrospective analysis of cumulative harvest in these three fisheries between the LFH released yearlings and harvest of subyearling groups that have been proposed as replacements (LFH release, Big Canyon, Grande Ronde, and Couse Creek) for the 2008-2020 run years. During this time frame, releases from the subyearling groups were different than what is currently being proposed so reported harvest was adjusted to reflect the proposed production levels. For example, the LFH subyearling release was only 200,000 fish annually. The proposed release would increase to 1.2 million total. To account for the extra 1.0 million, the reported harvest for this release group was multiplied by 5 for the replacement value. The reported harvest for the three other proposed subyearling groups (Big Canyon/Clearwater, Grande Ronde, Couse Creek) were estimated by multiplying the reported harvest by 40%, 20%, and 0%, respectively, and based on previous releases from these sites to account for the additional production proposed. In addition, due to a lack of releases in some years from the Grande Ronde or Couse Creek sites, expected harvest was derived from regressions with the LFH subyearling release where common years were available (Grande Ronde – 2011-2020; Couse Creek – 2008-2015).

In addition to estimating what overall harvest numbers might have been with additional subyearling production, the estimated harvest was broken down by age, and size at age (both length and estimated weight). A sample of fork lengths measured from the various recovery locations are reported in RMIS.

Zone 6 Tribal Net Fishery Summary

Between 2008-2020, an estimated 16,067 LFH adult and jacks released as yearlings were harvested in the Zone 6 Tribal Net Fishery (Table 2). Comparatively, subyearling production as proposed would result in an estimated 17,934 fish contribute to the Zone 6 harvest (1,867 more fish total, or 144 more per year). Size and age of fish within the Zone 6 Tribal Net Fishery for these years is also provided (Figures 16, 17, and 18).

Table 2. Cumulative estimated harvest of Lyons Ferry Hatchery released yearlings in the Zone 6 Net Fishery and estimated harvest using proposed subyearling groups (2008-2020 return years).

Age	LFH Yearlings	Total Subyearling	Proposed Subyearlings			
			Lyons Ferry	Grande Ronde	Couse Creek	Big Canyon
Jack	3,570	790	548	43	104	95
2-Salt	10,978	9,494	6,660	250	1,076	1,508
3-Salt	1,424	7,128	4,620	328	1,014	1,166
4/5-Salt	95	522	305	29	85	103
Total	16,067	17,934				

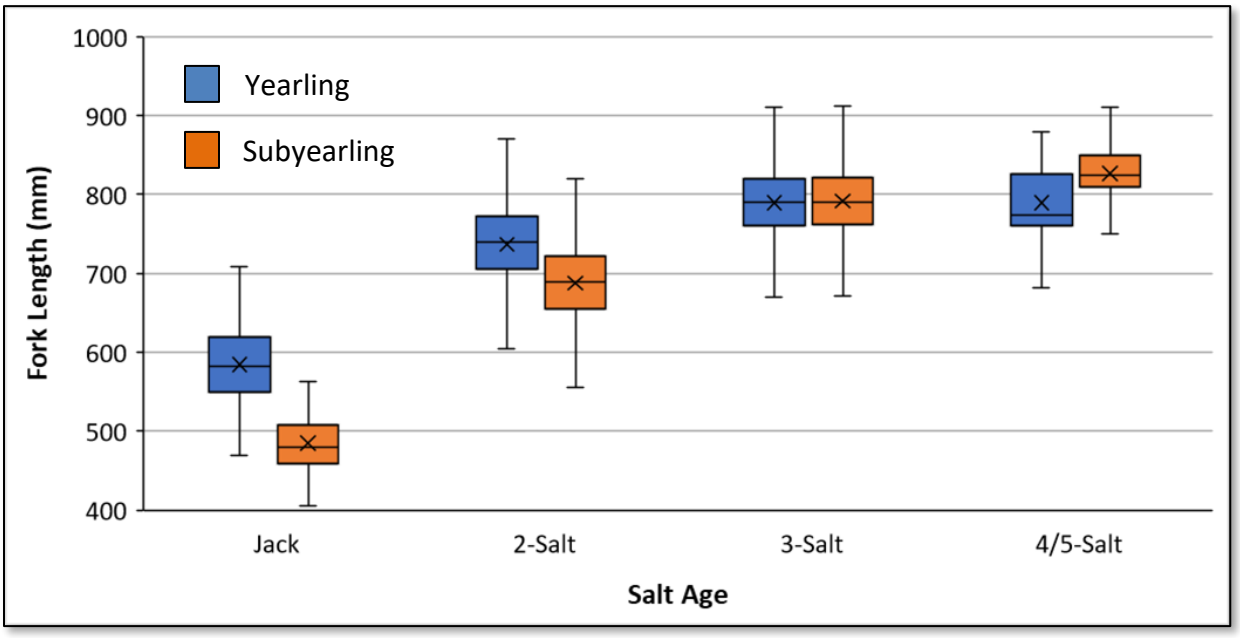


Figure 16. Box-Whisker plots showing size at age distribution for Snake River Fall Chinook yearlings and subyearlings in the Zone 6 Tribal Net Fishery, return years 2008-2020. The horizontal line inside the box represents the median, and "x" in the box represents the mean. Note: 600 mm is roughly equivalent to 24 inches in length.

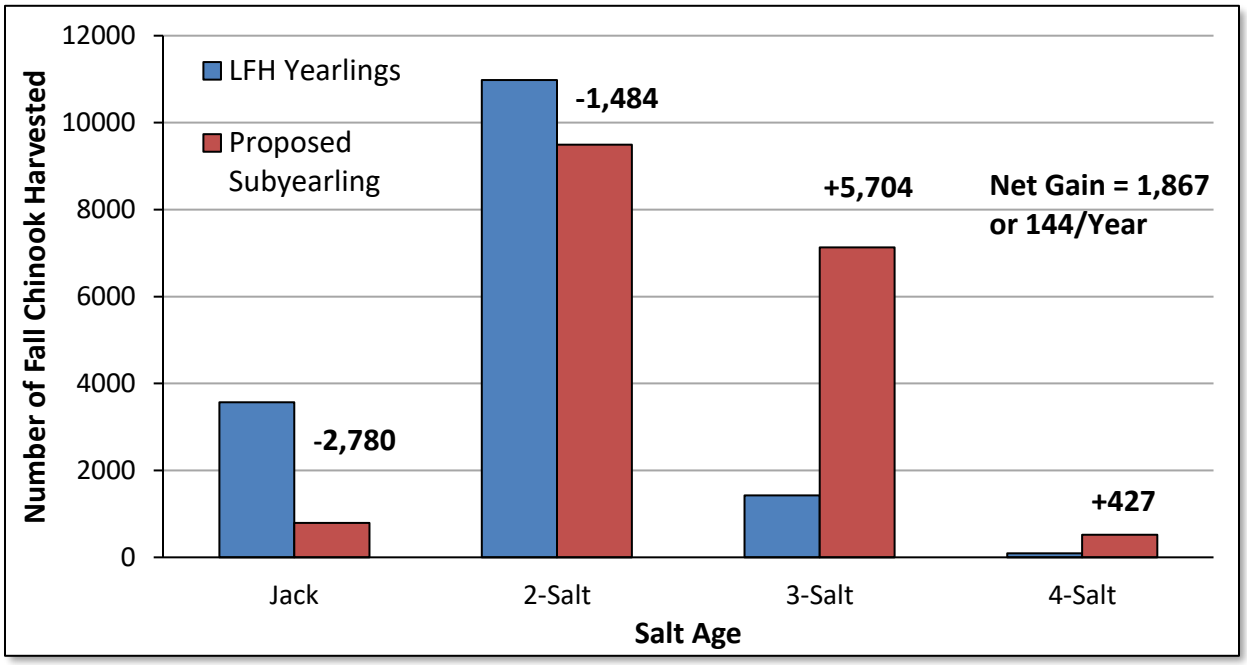


Figure 17. Cumulative contributions to harvest by age class from Lyons Ferry Hatchery released yearlings and the proposed replacement with subyearlings into the Zone 6 Tribal Net Fishery (2008-2020).

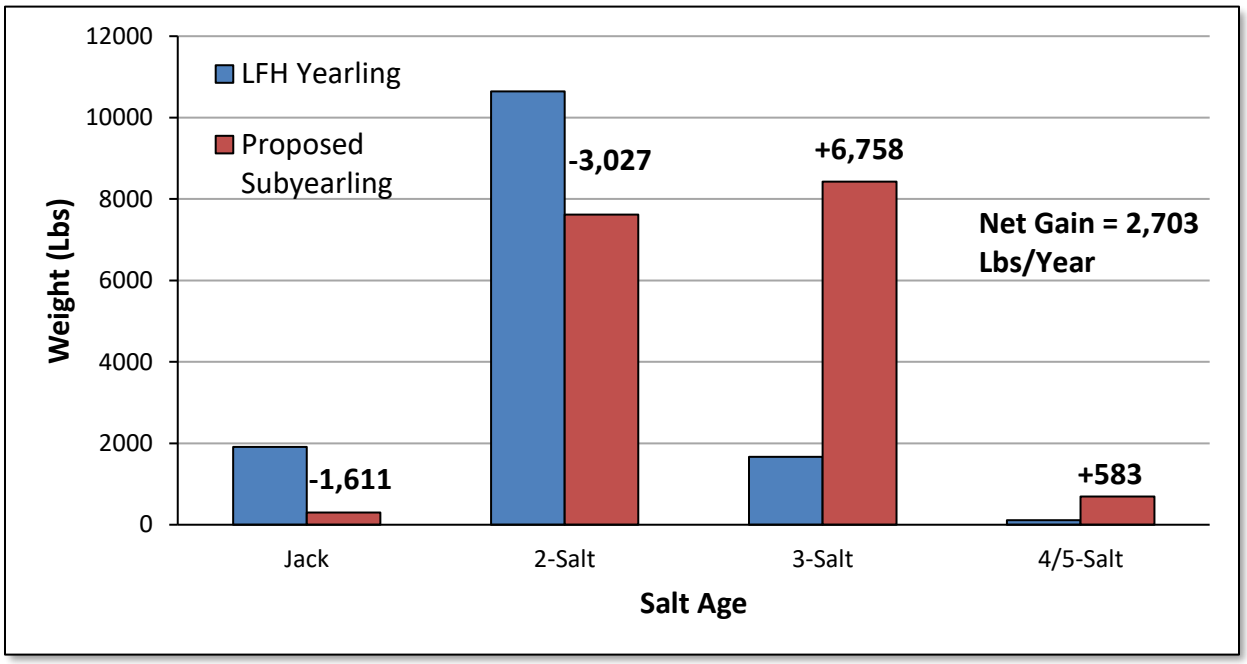


Figure 18. Estimated average annual pounds of adults (including jacks) from Lyons Ferry Hatchery released yearlings compared to the proposed replacement with subyearlings harvested in the Zone 6 Tribal Net Fishery (2008-2020).

Below Bonneville Dam Non-Tribal Commercial Net Fishery Summary

Between 2008-2020, an estimated 4,388 LFH adults and jacks released as yearlings were harvested in the Below Bonneville Non-Tribal Commercial Net Fishery (Table 3). As hypothetically proposed, subyearling production would have contributed 868 more adults (5,256 total). Size and age of fish within the Below Bonneville Net Fishery for these years is also provided (Figures 19, 20, and 21).

Table 3. Cumulative estimated harvest of Lyons Ferry Hatchery released yearlings in the Below Bonneville Dam Non-Tribal Commercial Net Fishery and estimated harvest using proposed subyearling groups (2008-2020 return years).

Age	LFH Yearlings	Total Subyearling	Proposed Subyearlings			
			Lyons Ferry	Grande Ronde	Couse Creek	Big Canyon
Jack	965	230	107	9	67	47
2-Salt	2,858	1,834	1,275	65	199	295
3-Salt	561	2,931	1,942	112	379	498
4/5-Salt	4	261	173	8	31	49
Total	4,388	5,256				

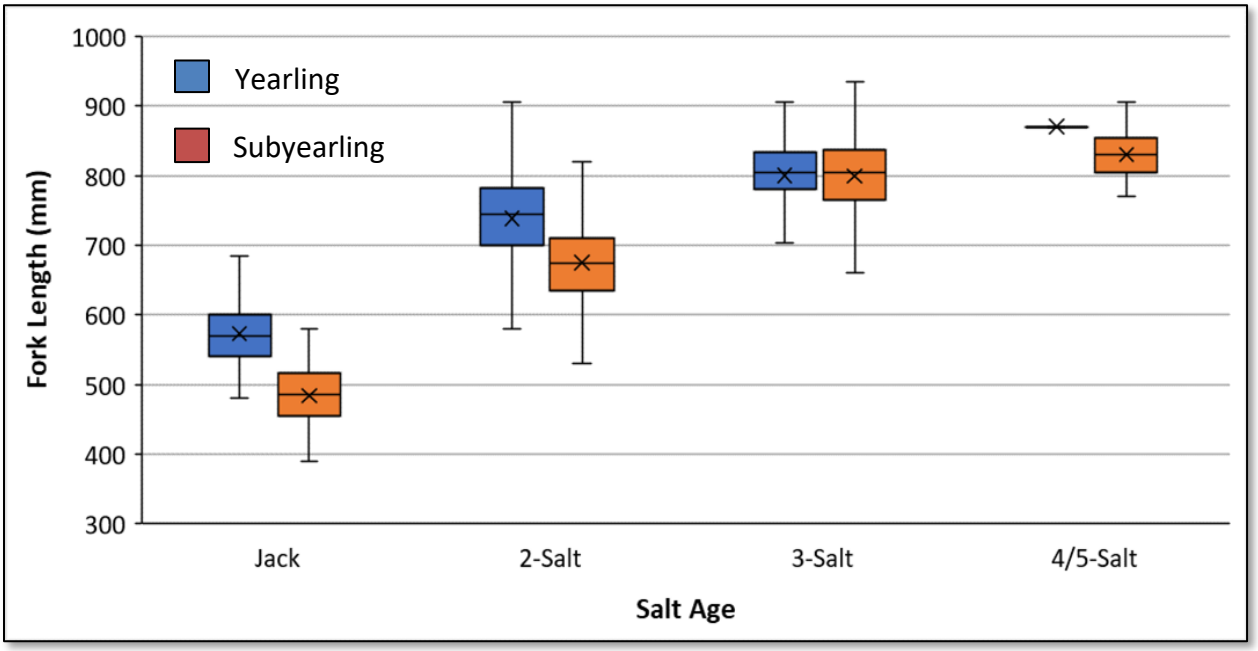


Figure 19. Box-Whisker plots showing size at age distribution for Snake River Fall Chinook yearlings and subyearlings in the Below Bonneville Dam Non-Tribal Net Fishery, return years 2008-2020. The horizontal line inside the box represents the median, and "x" in the box represents the mean. Note: 600 mm is roughly equivalent to 24 inches in length.

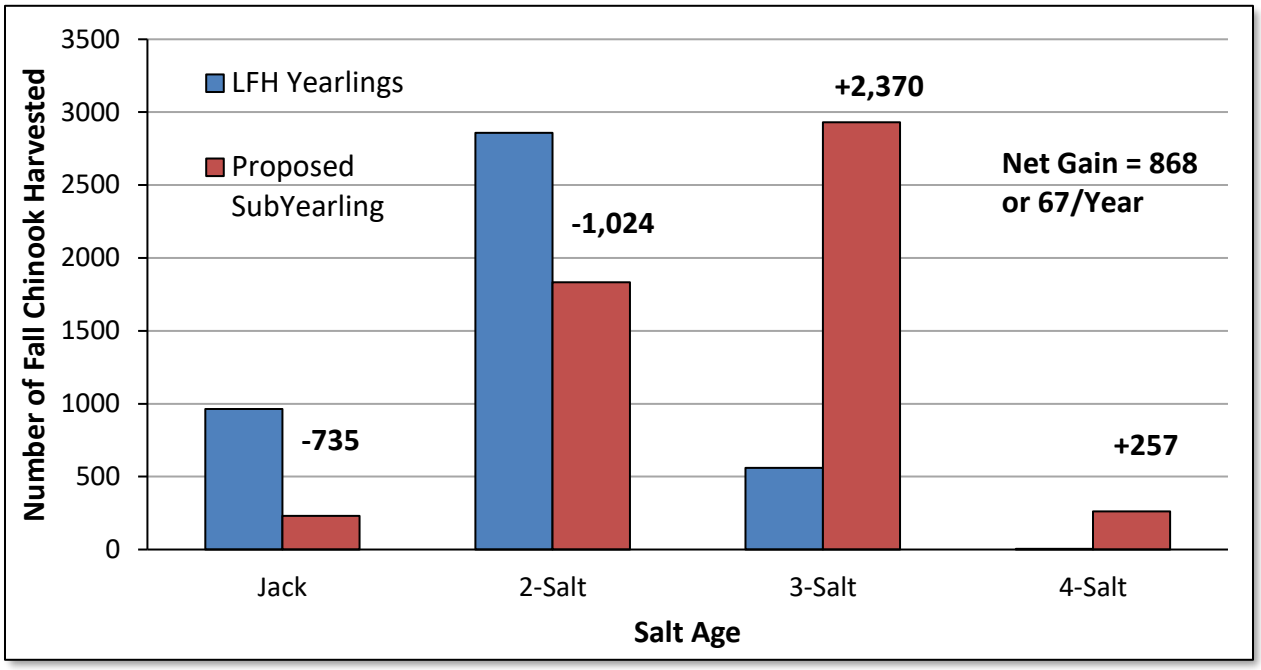


Figure 20. Cumulative contributions to harvest by age class from Lyons Ferry Hatchery released yearlings and the proposed replacement with subyearlings into the Below Bonneville Non-Tribal Net Fishery (2008-2020).

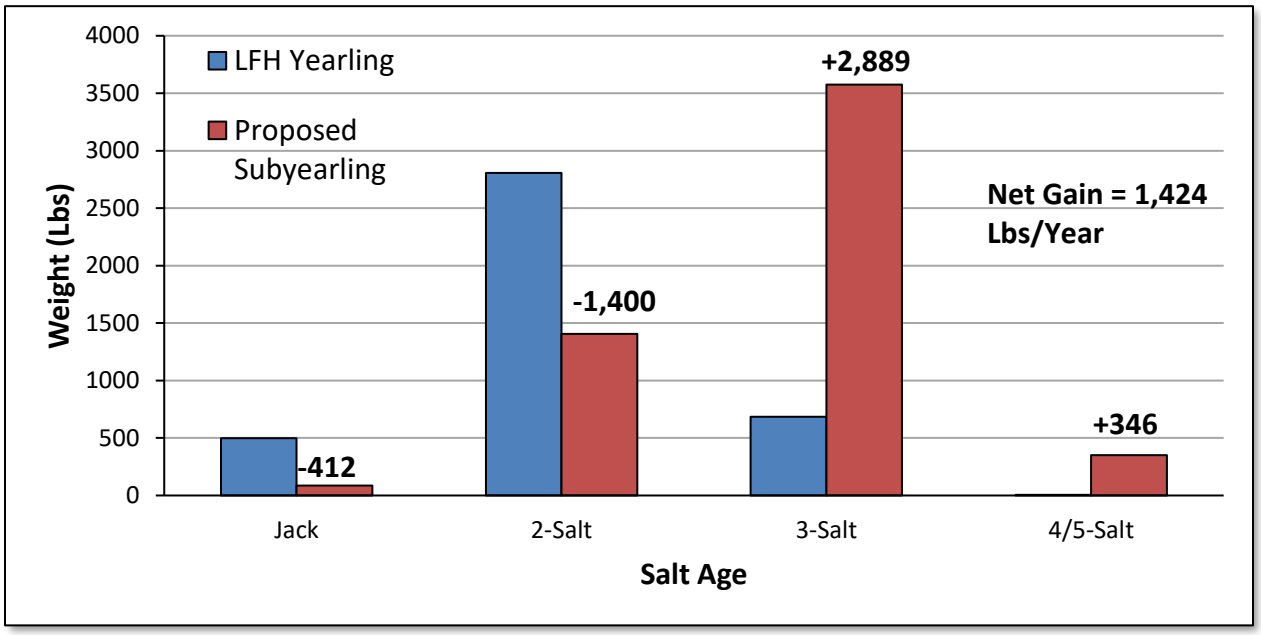


Figure 21. Estimated average annual pounds of adults (including jacks) from Lyons Ferry Hatchery released yearlings compared to the proposed replacement with subyearlings harvested in the Below Bonneville Non-Tribal Net Fishery (2008-2020).

Below Bonneville Sport Fisheries Summary

Between 2008-2020, an estimated 6,070 LFH released yearlings (adults and jacks) were harvested in the Below Bonneville Sport Fishery (Table 4). As proposed subyearling production would have had an estimated 7,745 fish contribute to this fishery (1,675 more fish total, or 129 more per year). Size and age of fish within the Below Bonneville Sport Fishery for these years is also provided (Figures 22, 23, and 24).

Table 4. Cumulative estimated harvest of Lyons Ferry Hatchery released yearlings in the Below Bonneville Sport Fishery and estimated harvest using proposed subyearling groups (2008-2020 return years).

Age	LFH Yearlings	Total Subyearling	Proposed Subyearlings			
			Lyons Ferry	Grande Ronde	Couse Creek	Big Canyon
Jack	2,193	1,285	994	15	137	139
2-Salt	3,470	4,229	2,857	180	558	634
3-Salt	407	2,078	1,355	95	294	334
4/5-Salt	0	153	107	6	19	21
Total	6,070	7,745				

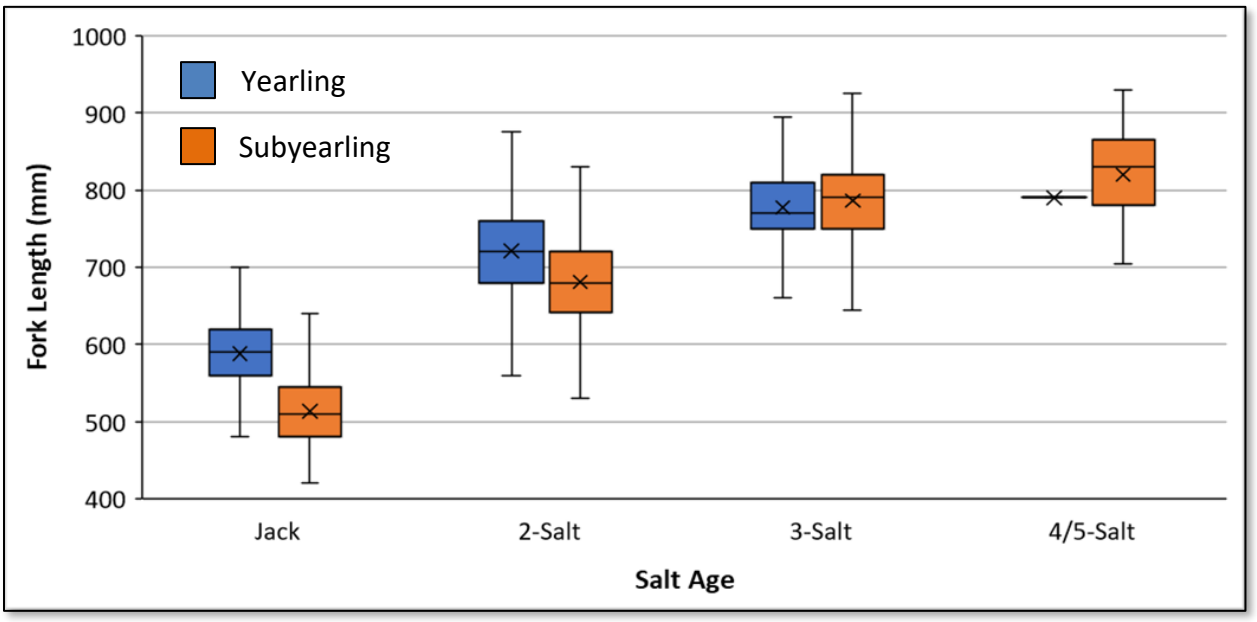


Figure 22. Box-Whisker plots showing size at age distribution for Snake River Fall Chinook yearlings and subyearlings in the Below Bonneville Dam Sport Fishery, return years 2008-2020. The horizontal line inside the box represents the median, and "x" in the box represents the mean. Note: 600 mm is roughly equivalent to 24 inches in length.

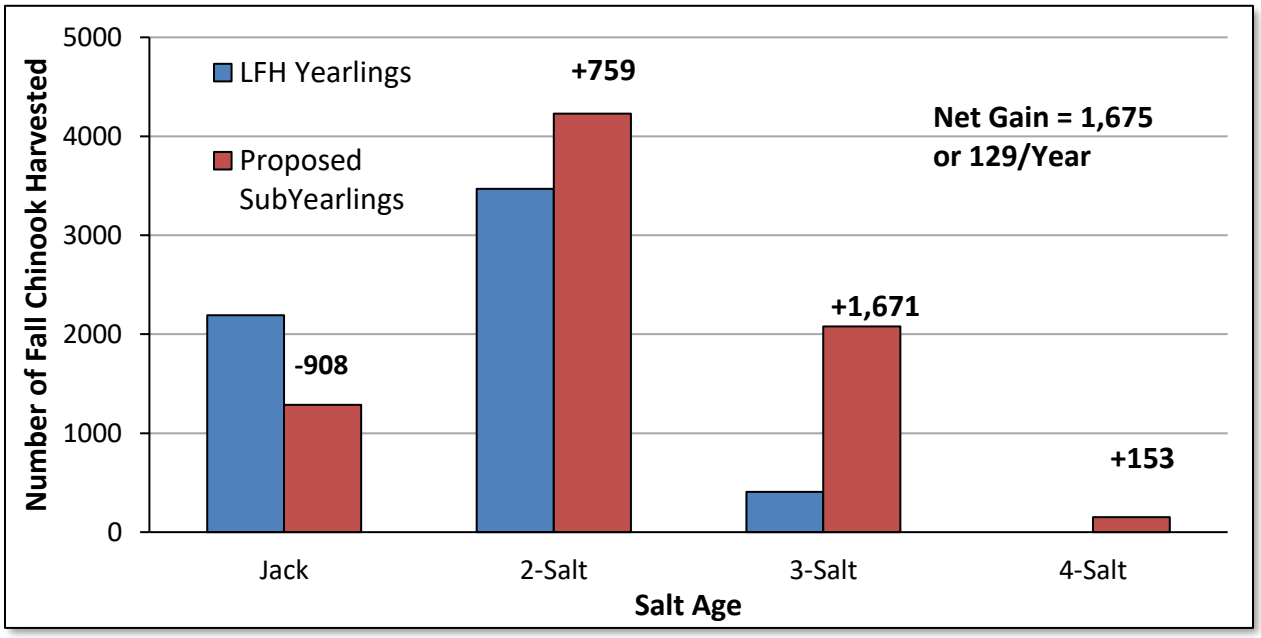


Figure 23. Cumulative contributions to harvest by age class from Lyons Ferry Hatchery released yearlings and the proposed replacement with subyearlings into the Below Bonneville Sport Fishery (2008-2020).

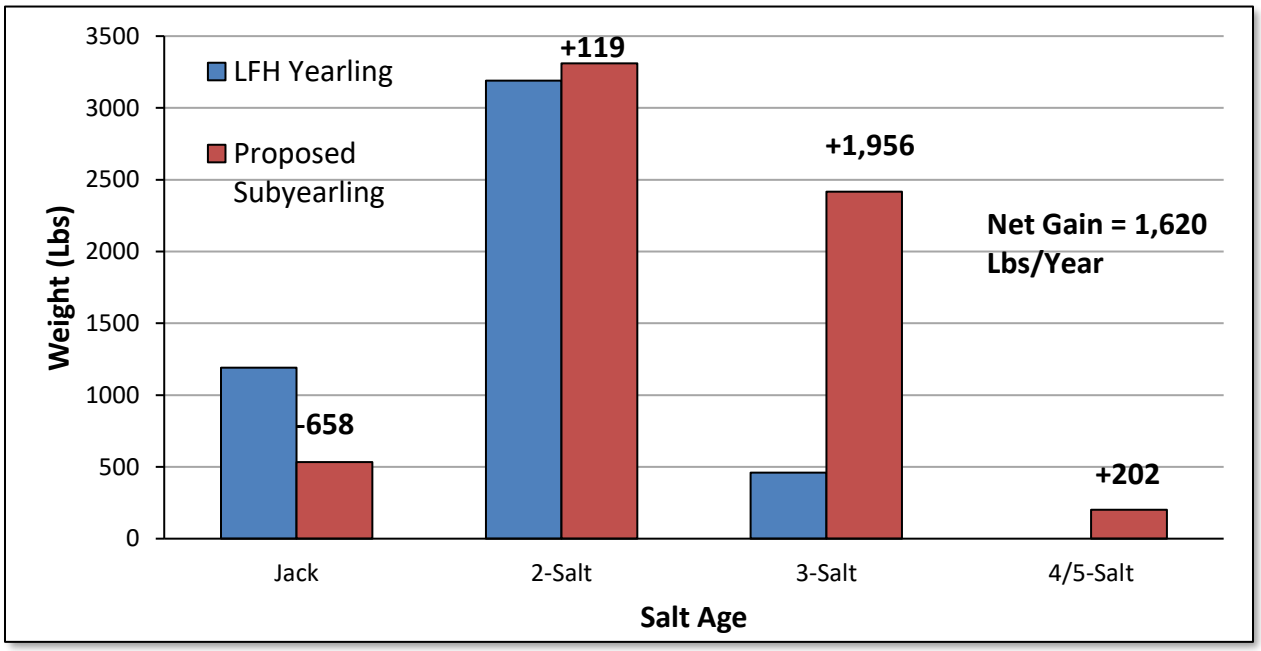


Figure 24. Estimated average annual pounds of adults (including jacks) from Lyons Ferry Hatchery released yearlings compared to the proposed replacement with subyearlings harvested in the Below Bonneville Sport Fishery (2008-2020).

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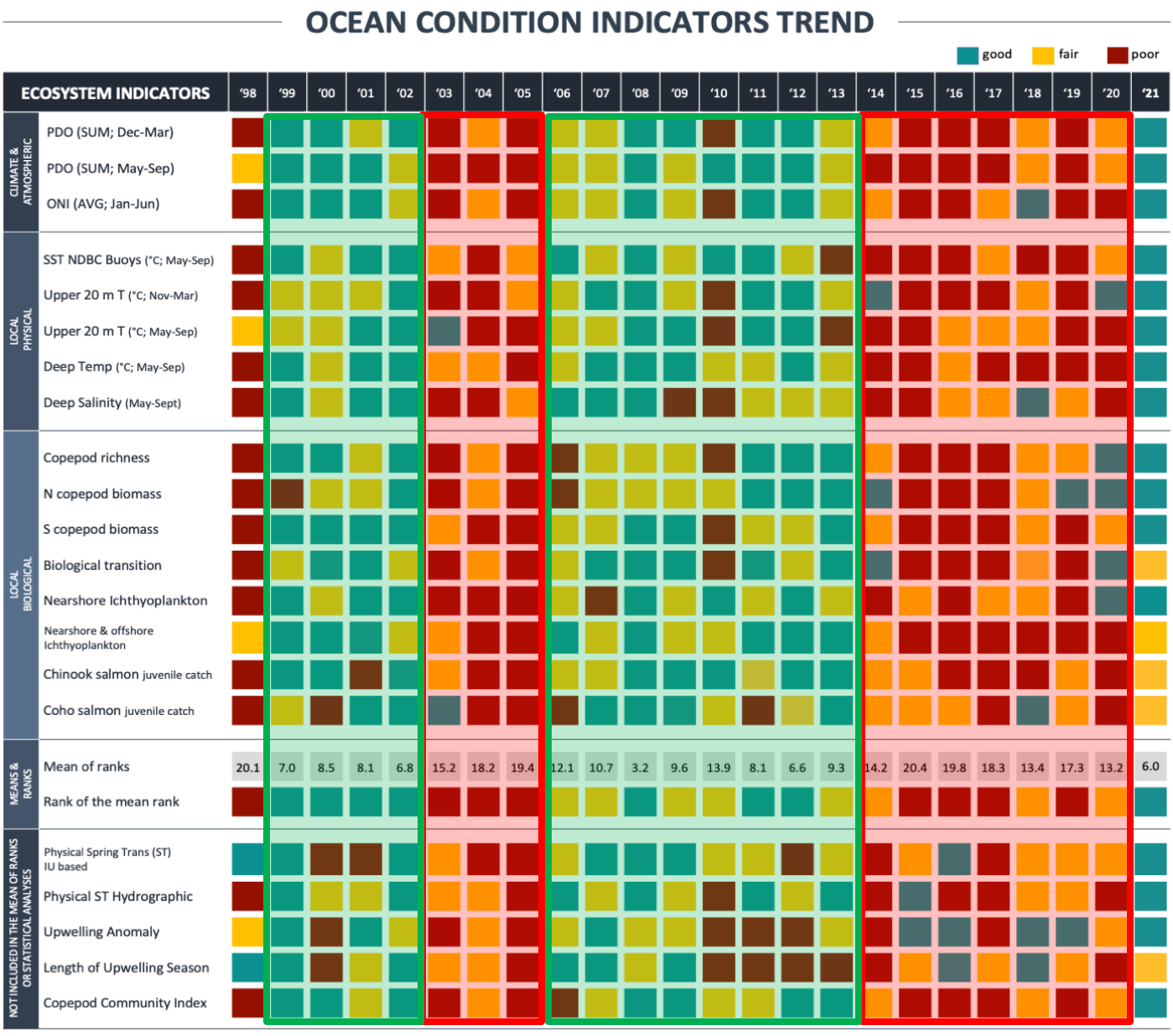
Appendix A. 2018-2027 US v Oregon Management Agreement Snake River Fall Chinook Production Table

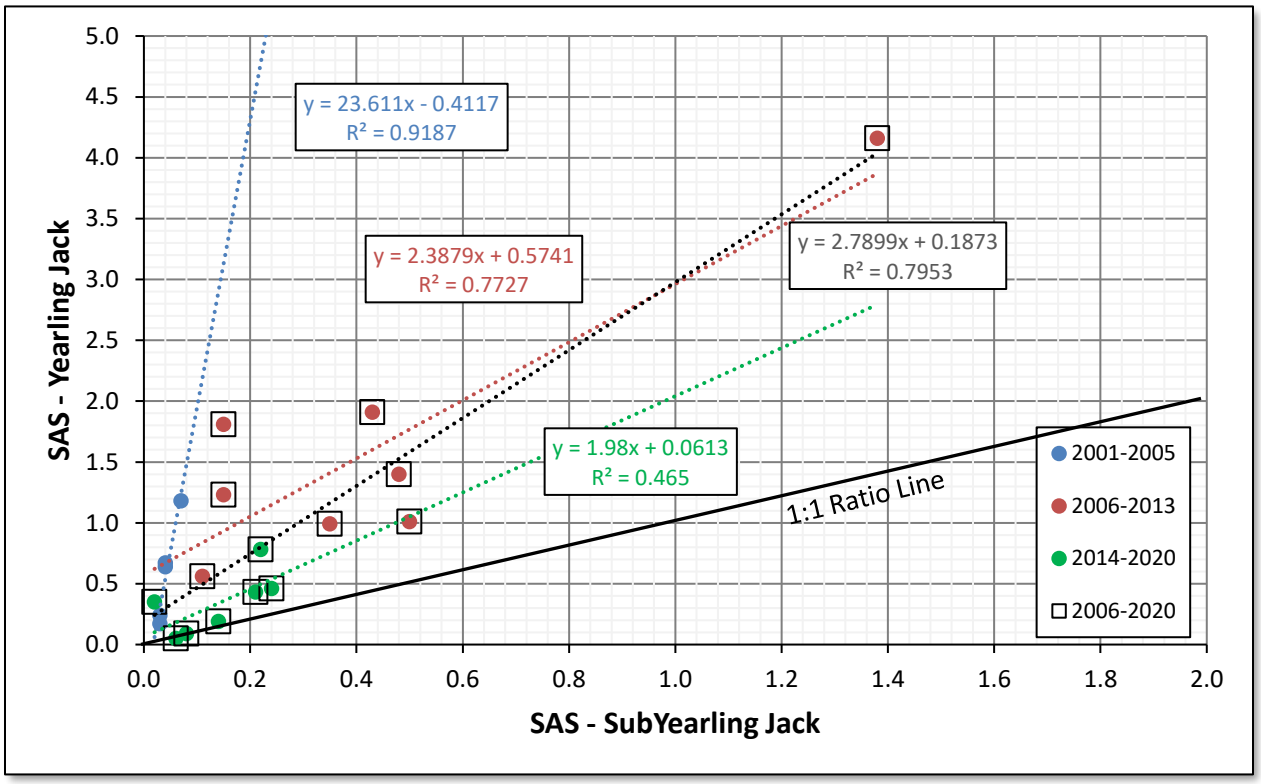
Appendix A, Table A1. Snake River Fall Chinook Salmon US v Oregon Production Table.

Lyons Ferry and Irrigon Hatchery Production							
Priority #	**Rear Facility**	**Release #**	**Age**	**Release Location**	**Marking/Tagging**	**AD/CWT**	**Unmarked**
1	Lyons Ferry	450,000	1+	On Station	450K AdCWT	450,000	0
2	Lyons Ferry	450,000	0+	CJ #1	200K AdCWT, 250K Unmarked	200,000	250,000
3	Lyons Ferry	450,000	0+	BC #1	200K AdCWT, 250K Unmarked	200,000	250,000
4	Lyons Ferry	500,000	0+	On Station	200K AdCWT, 300K Unmarked	200,000	300,000
5	Lyons Ferry	400,000	0+	PL #1	200K AdCWT, 200K Unmarked	200,000	200,000
6	Lyons Ferry	200,000	0+	CJ #2	200K AdCWT	200,000	0
7	Lyons Ferry	200,000	0+	BC#2	200K AdCWT	200,000	0
8	Lyons Ferry	200,000	0+	PL #2	200K AdCWT	200,000	0
9	Irrigon	1,000,000	0+	Salmon	200K AdCWT, 800K Unmarked	200,000	800,000
10	Irrigon	200,000	0+	GR	200K AdCWT	200,000	0
11	Lyons Ferry	200,000	0+	On Station	200K Unmarked	0	200,000
Total		4,250,000					
Clipped		2,250,000					
Unclipped		2,000,000					
Nez Perce Tribal Hatchery Production							
Priority #	**Rear Facility**	**Release #**	**Age**	**Release Location**	**Marking/Tagging**	**AD/CWT**	**Unmarked**
1	NPTH	1,000,000	0+	On station	200K AdCWT, 800K Unmarked	200,000	800,000
2	NPTH	200,000	0+	Luke's Gulch	100K AdCWT, 100K Unmarked	100,000	100,000
3	NPTH	200,000	0+	Cedar Flats	100K AdCWT, 100K Unmarked	100,000	100,000
Total		1,400,000					
Clipped		400,000					
Unclipped		1,000,000					
Total Production		**5,650,000**					

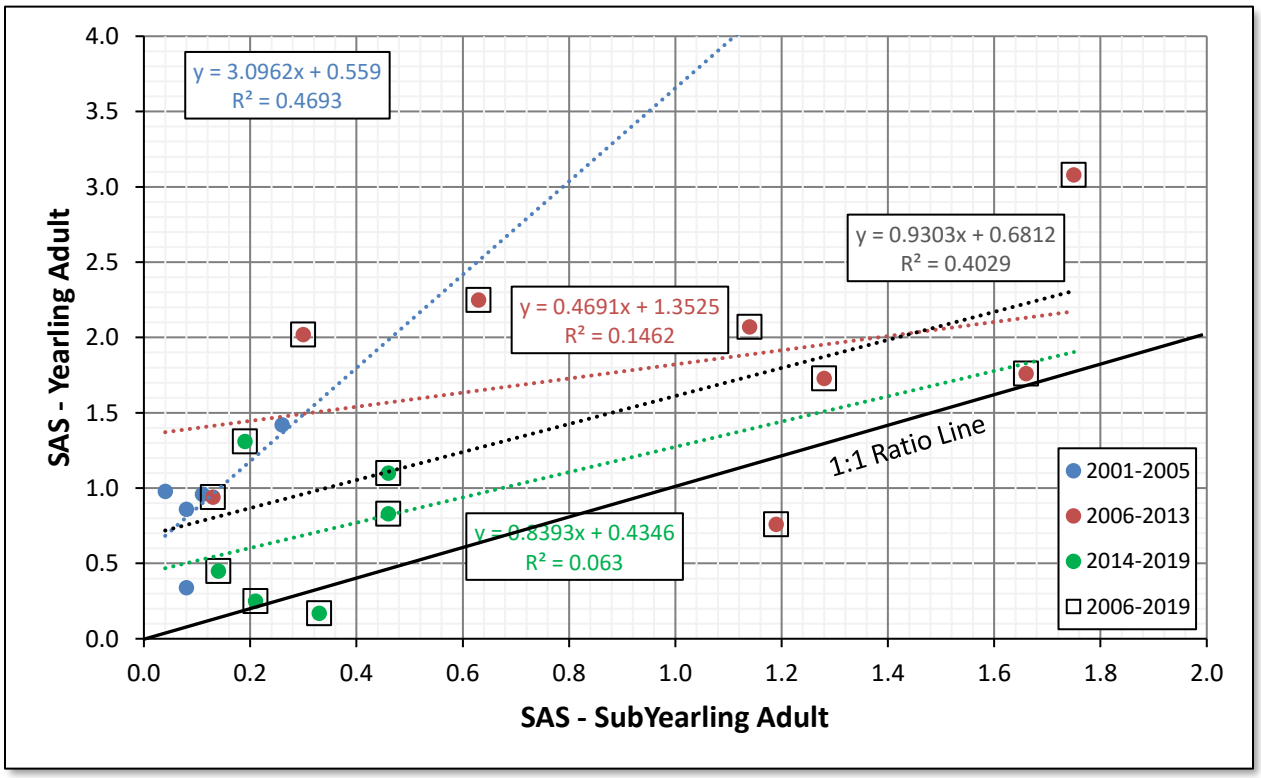
Appendix B. NOAA Fisheries Ocean Indicators, and Subyearling to Yearling Survival Ratio Analysis by Time Period

Appendix B, Figure B1. NOAA Fisheries Ocean Condition Indicators. Green shading indicates general periods of good ocean conditions (1999-2002 and 2006-2013), while red shading indicates general periods of poor ocean conditions (2003-2005 and 2014-2019).

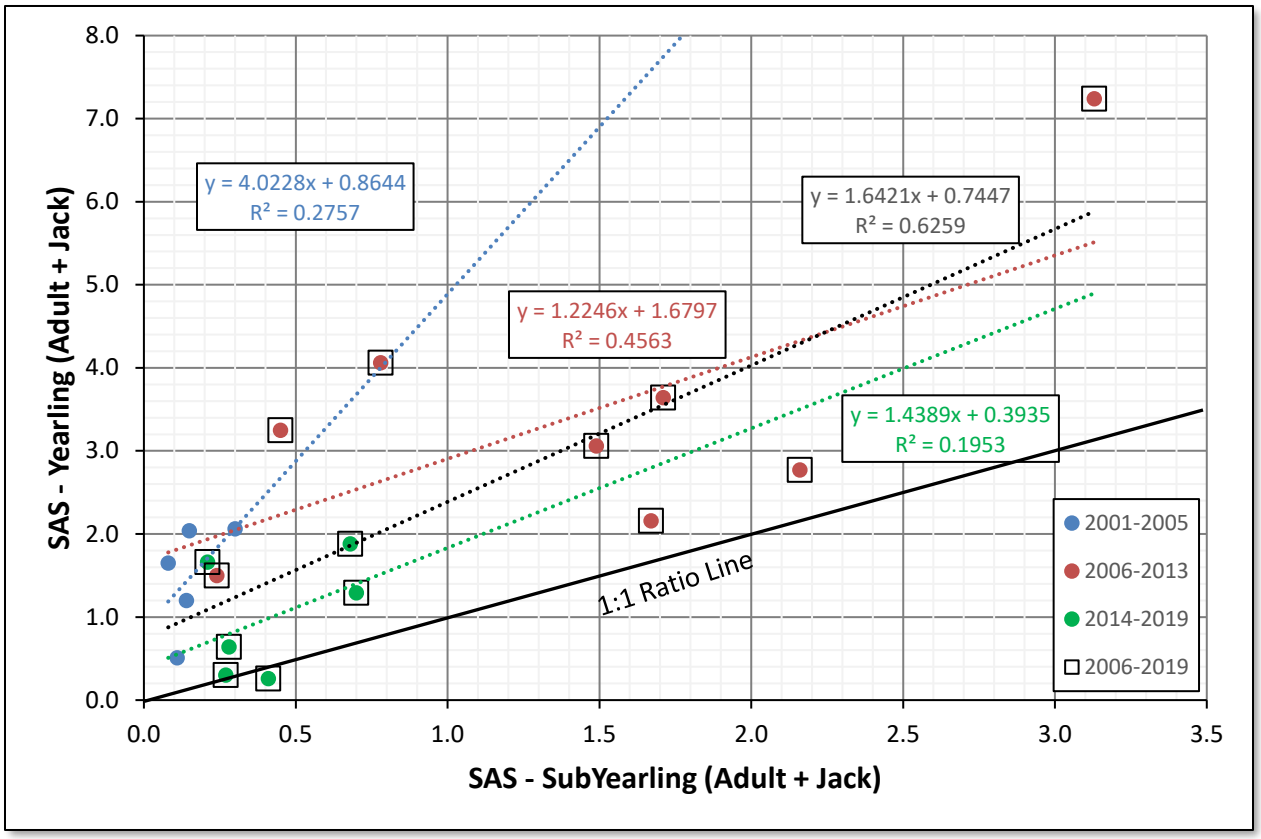




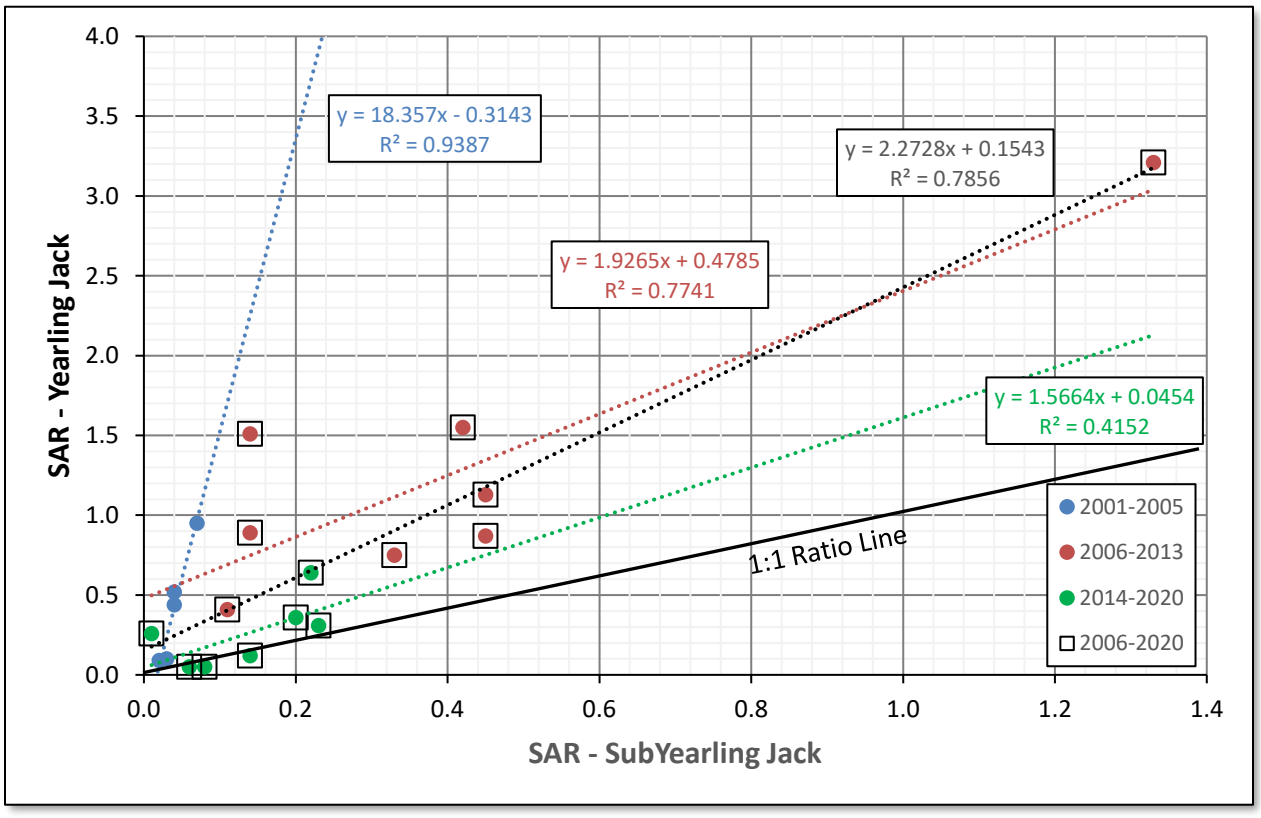
Appendix B, Figure B2. Smolt-to-Adult Survival (SAS) regressions of LFH released subyearling jacks to LFH released yearling jacks based on time period.



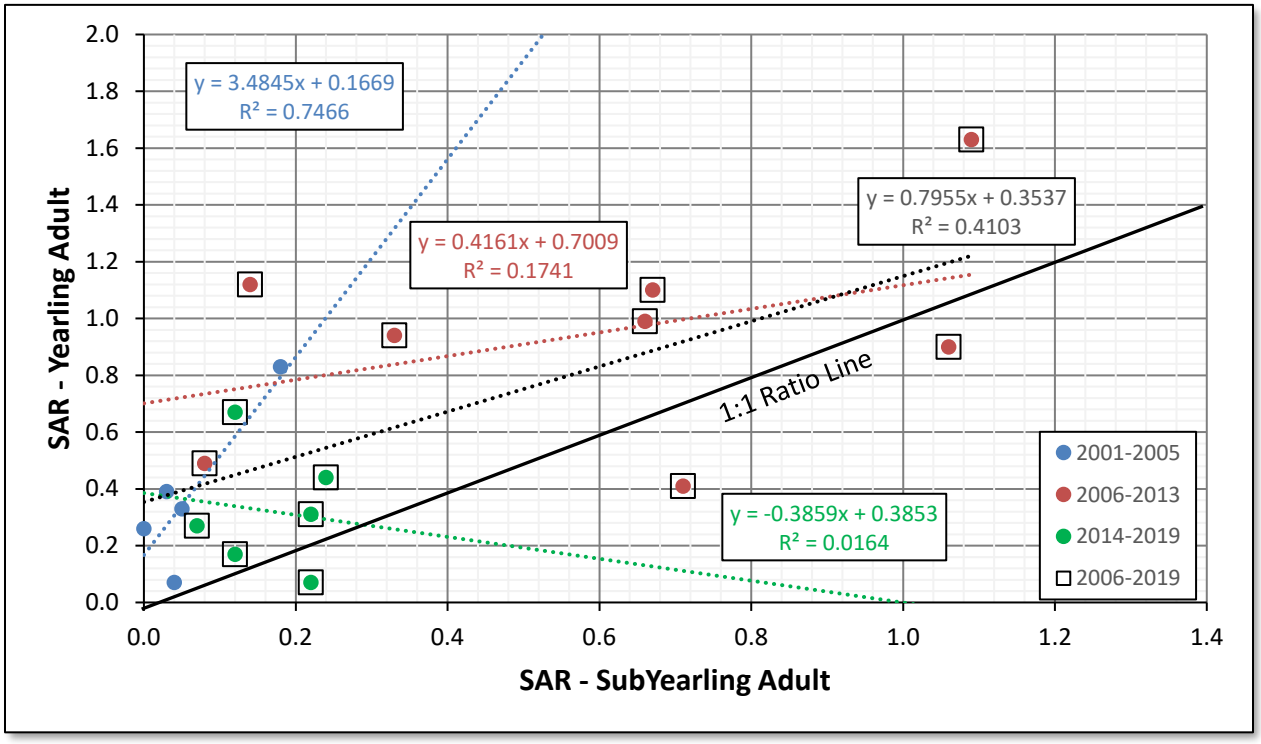
Appendix B, Figure B3. Smolt-to-Adult Survival (SAS) regressions of LFH released subyearling adults to LFH released yearling adults based on time period.



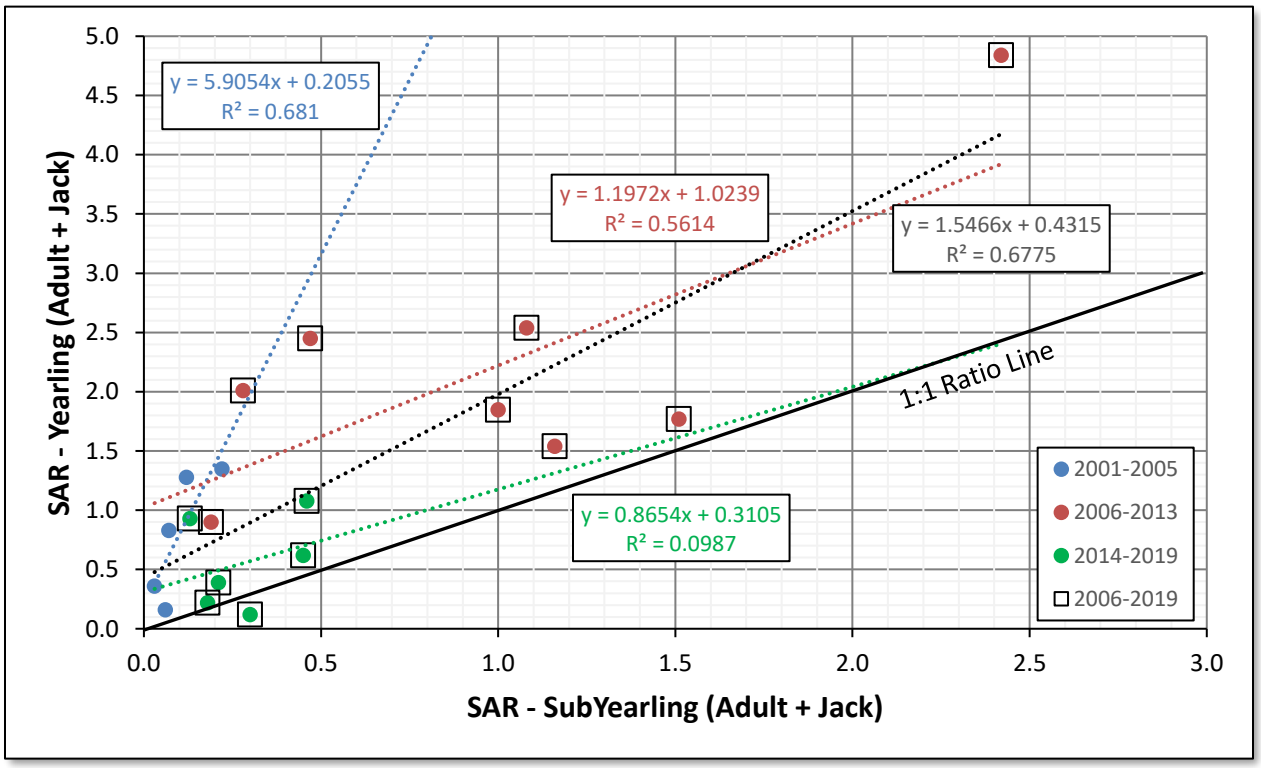
Appendix B, Figure B4. Smolt-to-Adult Survival (SAS) regressions of LFH released subyearling (adults+jacks) to LFH released yearling (adults+jacks) based on time period.



Appendix B, Figure B5. Smolt-to-Adult Return (SAR) regressions of LFH released subyearling jacks to LFH released yearling jacks based on time period.

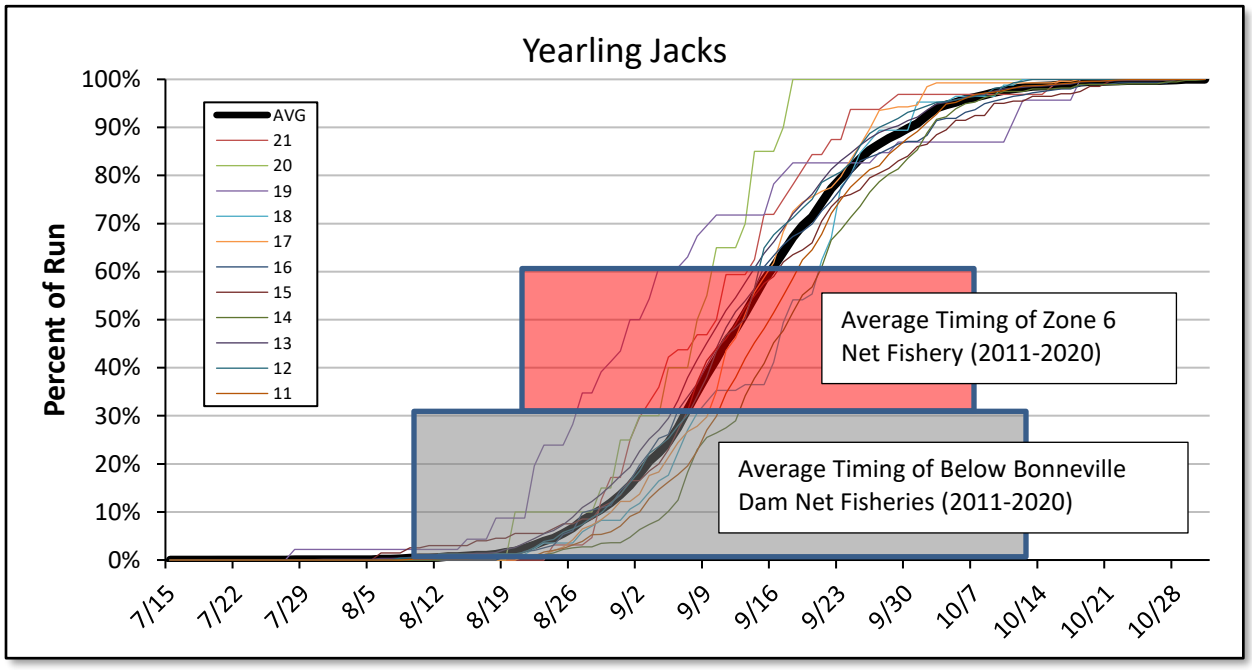


Appendix B, Figure B6. Smolt-to-Adult Return (SAR) regressions of LFH released subyearling adults to LFH released yearling adults based on time period.

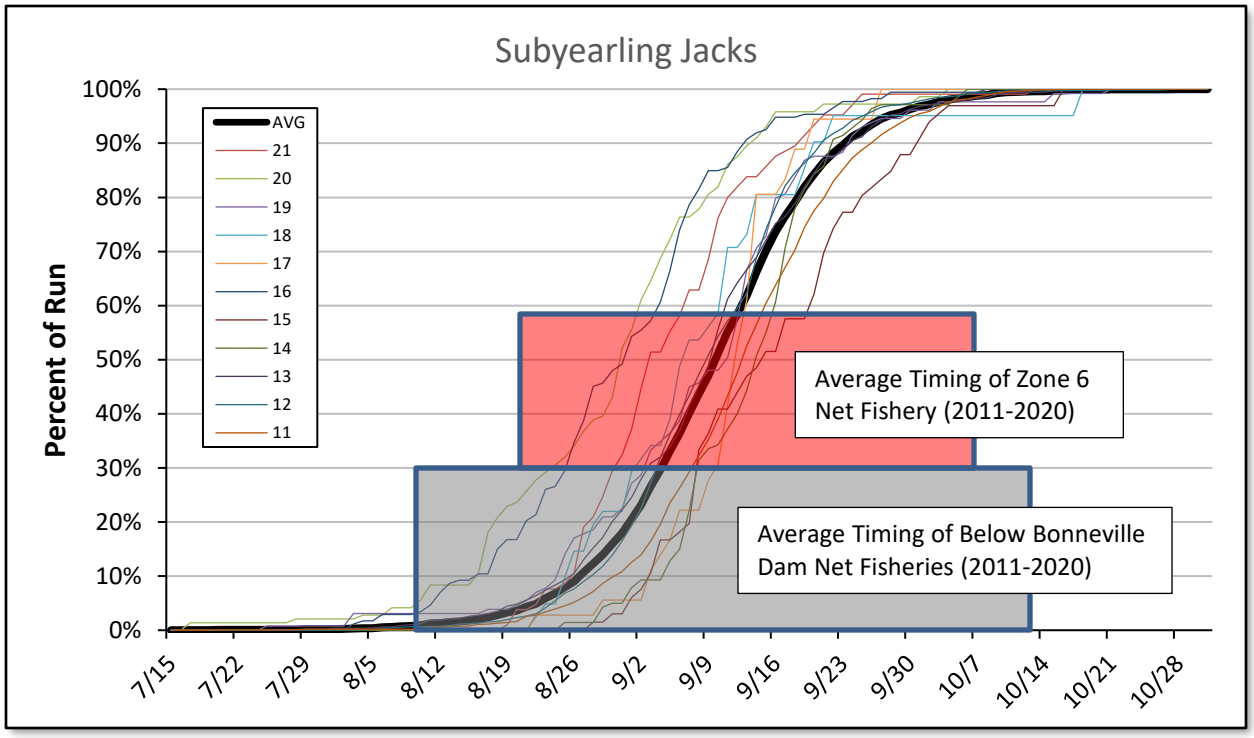


Appendix B, Figure B7. Smolt-to-Adult Return (SAR) regressions of LFH released subyearling (adults+jacks) to LFH released yearling (adults+jacks) based on time period.

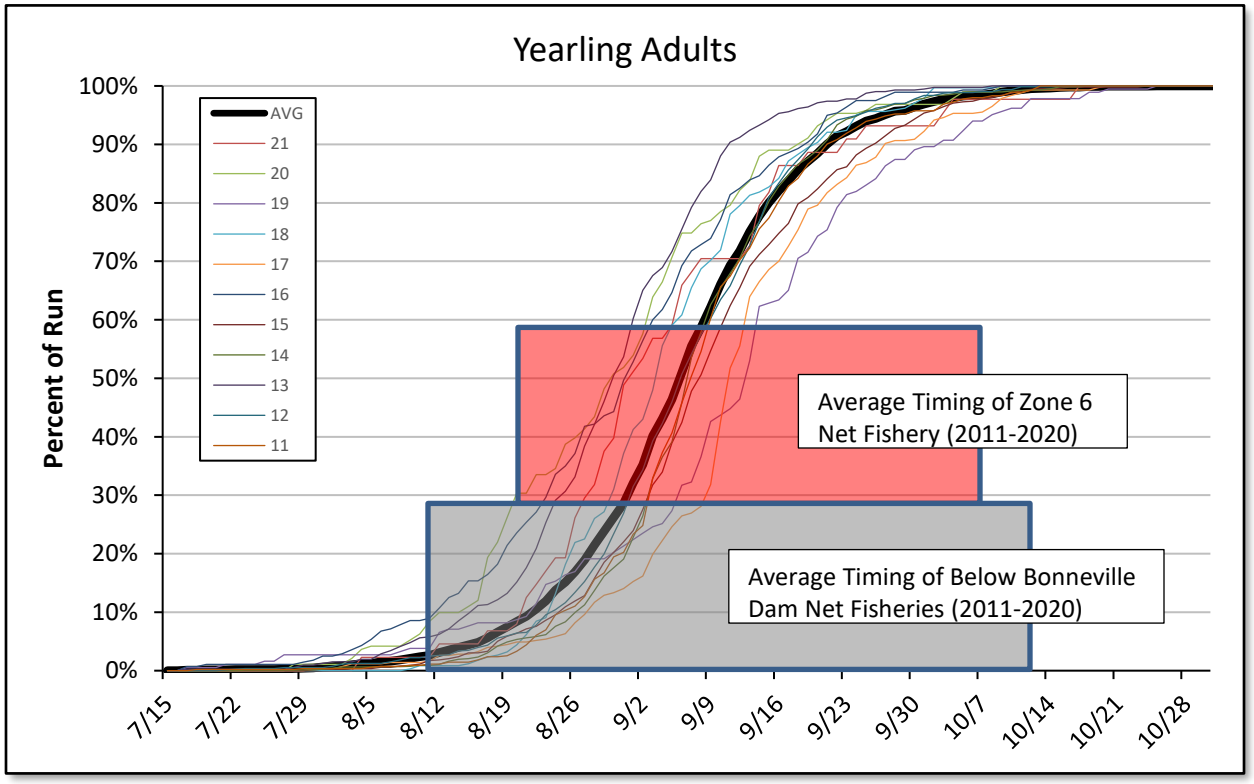
Appendix C. Run Timing of Yearling or Subyearling Fall Chinook Salmon (jacks or adults) at Bonneville Dam (2011-2021 Return Years) Based on PIT Tag Detections.



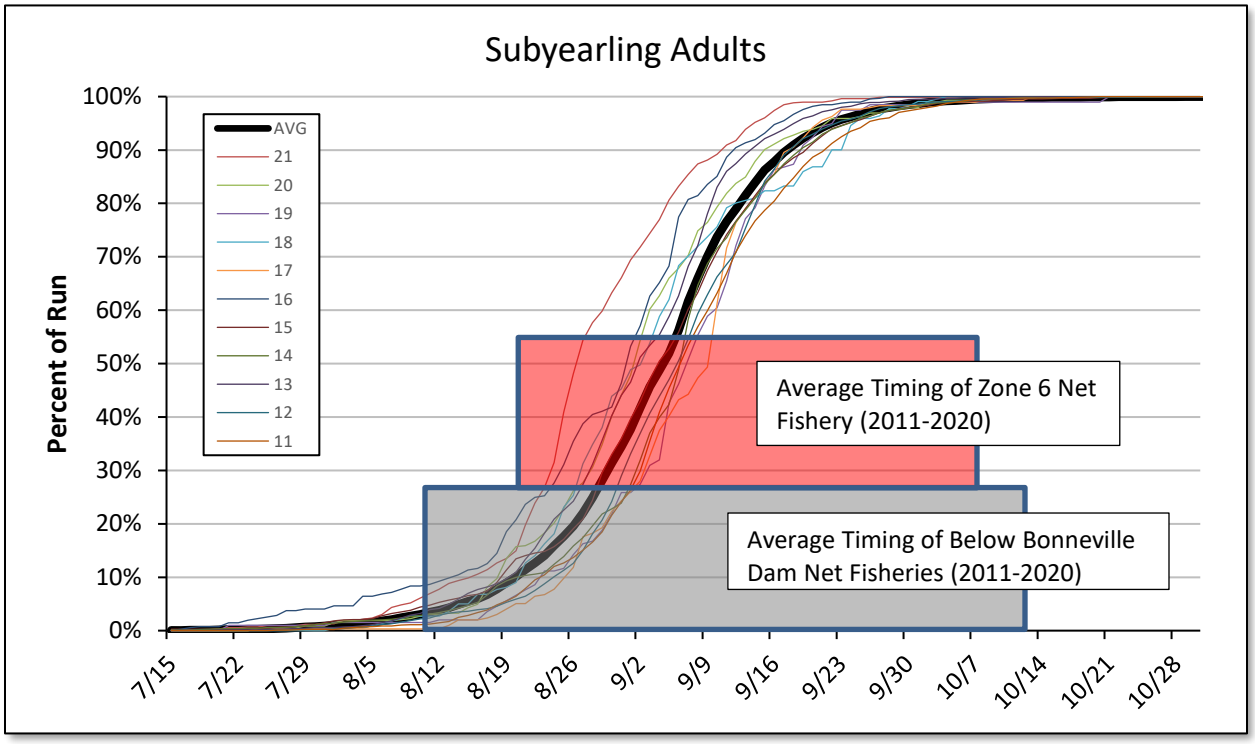
Appendix C, Figure C1. Run timing of Snake River Fall Chinook Salmon yearling jacks at Bonneville Dam, 2011-2021 return years.



Appendix C, Figure D2. Run timing of Snake River Fall Chinook Salmon subyearling jacks at Bonneville Dam, 2011-2021 return years.



Appendix C, Figure C3. Run timing of Snake River Fall Chinook Salmon yearling adults at Bonneville Dam, 2011-2021 return years.



Appendix C, Figure C4. Run timing of Snake River Fall Chinook Salmon subyearling adults at Bonneville Dam, 2011-2021 return years.

Appendix D. Smolt-to-Adult SAS and SAR Survivals from LFH Releases, SAS and SAR Survival from Proposed Release Sites Above LGD, and "Predicting" Tables using 2006-2017 or 2006-2018 Release Year Survivals

Appendix D, Table D1. Smolt-to-Adult Survival (SAS) and Smolt-to-Adult Return (SAR) rates of yearling and subyearling Snake River fall Chinook Salmon released at Lyons Ferry Hatchery (2006-2019 release years). The 2020 return of jacks shown are not included in the averages.

	Smolt-to-Adult Survival (SAS)						Smolt-to-Adult Return (SAR)					
Release Year	1+ Adult	1+ Jack	1+ Total	0+ Adult	0+ Jack	0+ Total	1+ Adult	1+ Jack	1+ Total	0+ Adult	0+ Jack	0+ Total
2006	0.76%	1.40%	2.16%	1.19%	0.48%	1.67%	0.41%	1.13%	1.54%	0.71%	0.45%	1.16%
2007	0.94%	0.56%	1.50%	0.13%	0.11%	0.24%	0.49%	0.41%	0.90%	0.08%	0.11%	0.19%
2008	3.08%	4.16%	7.24%	1.75%	1.38%	3.13%	1.63%	3.21%	4.84%	1.09%	1.33%	2.42%
2009	2.02%	1.23%	3.25%	0.30%	0.15%	0.45%	1.12%	0.89%	2.01%	0.14%	0.14%	0.28%
2010	1.73%	1.91%	3.64%	1.28%	0.43%	1.71%	0.99%	1.55%	2.54%	0.66%	0.42%	1.08%
2011	1.76%	1.01%	2.77%	1.66%	0.50%	2.16%	0.90%	0.81%	1.71%	1.06%	0.45%	1.51%
2012	2.25%	1.81%	4.06%	0.63%	0.15%	0.78%	0.94%	1.51%	2.45%	0.33%	0.14%	0.47%
2013	2.07%	0.99%	3.06%	1.14%	0.35%	1.49%	1.10%	0.75%	1.85%	0.67%	0.33%	1.00%
2014	1.10%	0.78%	1.88%	0.46%	0.22%	0.68%	0.44%	0.64%	1.08%	0.24%	0.22%	0.46%
2015	0.83%	0.46%	1.29%	0.46%	0.24%	0.70%	0.31%	0.31%	0.62%	0.22%	0.23%	0.45%
2016	1.31%	0.35%	1.66%	0.19%	0.02%	0.21%	0.67%	0.26%	0.93%	0.12%	0.01%	0.13%
2017	0.45%	0.19%	0.64%	0.14%	0.14%	0.28%	0.27%	0.12%	0.39%	0.07%	0.14%	0.21%
2018 [a]	0.25%	0.05%	0.30%	0.21%	0.06%	0.27%	0.17%	0.05%	0.22%	0.12%	0.06%	0.18%
2019 [a]	0.17%	0.09%	0.26%	0.33%	0.08%	0.41%	0.07%	0.05%	0.12%	0.22%	0.08%	0.30%
2020		0.43%			0.21%			0.36%			0.20	
06-19 Pooled	***1.34%***	***1.07%***	***2.41%***	***0.64%***	***0.28%***	***0.92%***	***0.68%***	***0.83%***	***1.52%***	***0.37%***	***0.27%***	***0.64%***
06-19 Mean	***1.34%***	***1.07%***	***2.41%***	***0.71%***	***0.31%***	***1.02%***	***0.68%***	***0.84%***	***1.52%***	***0.41%***	***0.29%***	***0.70%***
06-19 Geomean	***1.03%***	***0.63%***	***1.66%***	***0.49%***	***0.19%***	***0.68%***	***0.52%***	***0.48%***	***1.00%***	***0.28%***	***0.18%***	***0.46%***
06-18 Pooled	***1.43%***	***1.14%***	***2.57%***	***0.73%***	***0.32%***	***1.05%***	***0.73%***	***0.89%***	***1.62%***	***0.42%***	***0.31%***	***0.73%***
06-18 Mean	***1.43%***	***1.15%***	***2.57%***	***0.73%***	***0.32%***	***1.06%***	***0.73%***	***0.90%***	***1.62%***	***0.42%***	***0.31%***	***0.73%***
06-18 Geomean	***1.18%***	***0.73%***	***1.91%***	***0.51%***	***0.20%***	***0.71%***	***0.60%***	***0.57%***	***1.17%***	***0.18%***	***0.19%***	***0.47%***
06-17 Pooled	***1.53%***	***1.23%***	***2.76%***	***0.78%***	***0.35%***	***1.13%***	***0.77%***	***0.96%***	***1.73%***	***0.45%***	***0.33%***	***0.78%***
06-17 Mean	***1.53%***	***1.24%***	***2.76%***	***0.78%***	***0.35%***	***1.12%***	***0.77%***	***0.97%***	***1.74%***	***0.45%***	***0.33%***	***0.78%***
06-17 Geomean	***1.34%***	***0.91%***	***2.25%***	***0.55%***	***0.22%***	***0.77%***	***0.67%***	***0.69%***	***1.36%***	***0.30%***	***0.21%***	***0.51%***

[a] Returns are incomplete due to a lag in reporting, or from older age classes (3-salt and 4-salt) that may still return but have been estimated using sibling regressions.

Appendix D, Table D2. Smolt-to-Adult Survival (SAS) and Smolt-to-Adult Return (SAR) rates of subyearling Snake River Fall Chinook Salmon released in the Grande Ronde River, Big Canyon Acclimation Site (Clearwater), or at Couse Creek in the Snake River (2006-2019 release years). Couse Creek releases from 2007, 2014-2019 were estimated using a regression relationship with LFH subyearlings (SAS Jacks R^2 = 0.95, SAS Adults R^2 = 0.76; SAR Jacks R2 = 0.94, SAR Adults R2 = 0.73). Grande Ronde survival was estimated for the 2007 release, again using LFH subyearling releases (SAS Jacks R^2 = 0.72, SAS Adults R^2 = 0.53; SAR Jacks R2 = 0.74, SAR Adults R2 = 0.50). Grey highlighted areas were estimated using regression relationships with LFH released subyearlings as survival was not available for these groups since there were no releases at these sites for these years.

Release Year	Smolt-to-Adult Survival (SAS)						Smolt-to-Adult Return (SAR)					
	GRR Adult	GRR Jack	CCR Adult	CCR Jack	BC Adult	BC Jack	GRR Adult	GRR Jack	CCR Adult	CCR Jack	BC Adult	BC Jack
2006	0.18%	0.06%	1.21%	0.26%	0.90%	0.26%	0.07%	0.05%	0.75%	0.23%	0.50%	0.25%
2007	0.25%	0.02%	0.21%	0.03%	0.13%	0.08%	0.13%	0.02%	0.18%	0.04%	0.05%	0.07%
2008	0.36%	0.16%	1.01%	0.72%	2.00%	0.90%	0.29%	0.16%	0.53%	0.66%	1.11%	0.84%
2009	0.31%	0.08%	0.37%	0.04%	0.29%	0.16%	0.13%	0.07%	0.20%	0.03%	0.14%	0.16%
2010	1.36%	0.14%	1.16%	0.26%	1.31%	0.20%	0.64%	0.11%	0.61%	0.24%	0.67%	0.18%
2011	0.31%	0.08%	1.51%	0.35%	1.55%	0.28%	0.12%	0.08%	0.75%	0.32%	0.73%	0.25%
2012	0.99%	0.02%	0.46%	0.01%	1.34%	0.05%	0.47%	0.00%	0.26%	0.00%	0.68%	0.00%
2013	0.49%	0.07%	0.70%	0.12%	0.83%	0.07%	0.24%	0.06%	0.37%	0.10%	0.39%	0.04%
2014	0.32%	0.02%	0.43%	0.09%	0.58%	0.10%	0.23%	0.02%	0.26%	0.10%	0.23%	0.08%
2015	0.54%	0.13%	0.43%	0.11%	0.36%	0.07%	0.27%	0.12%	0.25%	0.10%	0.23%	0.06%
2016	0.02%	0.00%	0.25%	0.01%	0.34%	0.00%	0.01%	0.00%	0.20%	0.01%	0.22%	0.00%
2017	0.26%	0.10%	0.21%	0.05%	0.37%	0.05%	0.16%	0.10%	0.17%	0.06%	0.32%	0.05%
2018 [a]	0.44%	0.10%	0.26%	0.00%	0.54%	0.08%	0.30%	0.10%	0.20%	0.01%	0.39%	0.08%
2019 [a]	0.65%	0.14%	0.34%	0.02%	0.50%	0.07%	0.50%	0.13%	0.25%	0.02%	0.35%	0.07%
06-19 Pooled	***0.45%***	***0.08%***	***0.61%***	***0.15%***	***0.70%***	***0.16%***	***0.24%***	***0.07%***	***0.35%***	***0.13%***	***0.41%***	***0.15%***
06-19 Mean	***0.46%***	***0.08%***	***0.59%***	***0.15%***	***0.79%***	***0.17%***	***0.25%***	***0.07%***	***0.34%***	***0.14%***	***0.43%***	***0.15%***
06-19 Geomean	***0.34%***	***0.05%***	***0.48%***	***0.06%***	***0.61%***	***0.08%***	***0.18%***	***0.03%***	***0.30%***	***0.02%***	***0.34%***	***0.06%***
06-18 Pooled	***0.45%***	***0.07%***	***0.65%***	***0.18%***	***0.74%***	***0.18%***	***0.24%***	***0.07%***	***0.36%***	***0.16%***	***0.42%***	***0.16%***
06-18 Mean	***0.45%***	***0.08%***	***0.63%***	***0.16%***	***0.81%***	***0.18%***	***0.24%***	***0.07%***	***0.36%***	***0.15%***	***0.44%***	***0.16%***
06-18 Geomean	***0.32%***	***0.05%***	***0.50%***	***0.07%***	***0.62%***	***0.09%***	***0.17%***	***0.02%***	***0.31%***	***0.02%***	***0.34%***	***0.06%***
06-17 Pooled	***0.45%***	***0.07%***	***0.69%***	***0.18%***	***0.77%***	***0.19%***	***0.24%***	***0.06%***	***0.38%***	***0.17%***	***0.42%***	***0.18%***
06-17 Mean	***0.45%***	***0.07%***	***0.66%***	***0.17%***	***0.83%***	***0.18%***	***0.23%***	***0.07%***	***0.38%***	***0.16%***	***0.44%***	***0.17%***
06-17 Geomean	***0.1%***	***0.04%***	***0.53%***	***0.08%***	***0.63%***	***0.09%***	***0.16%***	***0.02%***	***0.32%***	***0.03%***	***0.33%***	***0.06%***

[a] Returns are incomplete due to a lag in reporting, or from older age classes (3-salt and 4-salt) that may still return but have been estimated using sibling regressions.

Appendix D, Table D3. Estimated additional production of subyearling Snake River fall Chinook Salmon (at various locations) to replace the current releases of yearlings at Lyons Ferry Hatchery (2006-2018 Release Years).

Release Group	Current Production	Additional Subyearling Production	Total Subyearling Production	SAS (%)	SAS Returns	SAR (%)	SAR Returns	AG [a] (%)	AG Returns
Pooled Survival Estimates (2006-2018 Release Years)									
LFH 1+	450,000			2.57%	11,565	1.62%	7,290	0.32%	1,458
LFH 0+	700,000	1,101,500 [b]		1.05%	11,566	0.73%	8,041	0.29%	3,216
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	1.05%	5,250	0.73%	3,650	0.29%	1,460
GRR 0+	200,000	300,000	500,000	0.52%	1,560	0.31%	930	0.30%	902
BC 0+ 2nd Rel	200,000	200,000	400,000	0.92%	1,840	0.58%	1,160	0.56%	1,125
CCR 0+	0	351,500	351,500	0.83%	2,917	0.52%	1,828	0.50%	1,773
Totals					11,567		7,568		5,260
Gains/Losses	***-450,000 (1+)***	***1,351,500 (0+)***			***+ 2***		***+ 278***		***+ 3,802***
Mean Survival Estimates (2006-2018 Release Years)									
LFH 1+	450,000			2.57%	11,579	1.62%	7,303	0.32%	1,461
LFH 0	700,000	1,093,500 [b]		1.06%	11,578	0.73%	8,028	0.29%	3,211
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	1.06%	5,294	0.73%	3,671	0.29%	1,468
GRR 0+	200,000	300,000	500,000	0.52%	1,572	0.30%	910	0.29%	883
BC 0+	200,000	200,000	400,000	0.99%	1,973	0.59%	1,189	0.58%	1,153
CCR 0+	0	347,000	247,000	0.79%	2,739	0.51%	1,765	0.49%	1,712
Totals					11,578		7,535		5,216
Gains/Losses	***-450,000 (1+)***	***1,347,000 (0+)***			***-1***		***+ 231***		***+ 3,755***
Geomean Survival Estimates (2006-2018 Release Years)									
LFH 1+	450,000			1.91%	8,590	1.17%	5,262	0.23%	1,052
LFH 0	700,000	1,213,000 [b]		0.71%	8,592	0.47%	5,714	0.19%	2,286
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	0.71%	3,542	0.47%	2,356	0.19%	942
GRR 0+	200,000	300,000	500,000	0.37%	1,108	0.19%	579	0.19%	562
BC 0+	200,000	200,000	400,000	0.71%	1,420	0.40%	791	0.38%	767
CCR 0+	0	442,000	442,000	0.57%	2,519	0.34%	1,485	0.33%	1,441
Totals					8,589		5,211		3,712
Gains/Losses	***-450,000 (1+)***	***1,442,000 (0+)***			***- 1***		***- 51***		***+ 2,660***

[a] AG = Above Lower Granite Dam. Based on the Radio Telemetry Study conducted from 2013-2017 (Cleary et al.), and from PIT Tag Conversions from Ice Harbor to Lower Granite, approximately 20% of the yearlings from LFH, 40% of the subyearlings from LFH, and 97% of the other releases above Lower Granite are estimated to return to and stay above Lower Granite on an annual basis.

[b] This is the number of LFH released subyearlings it would take to replace the 450,000 yearlings. Since LFH can only release another 500,000 on top of current production (700,000), then the additional production must occur elsewhere.

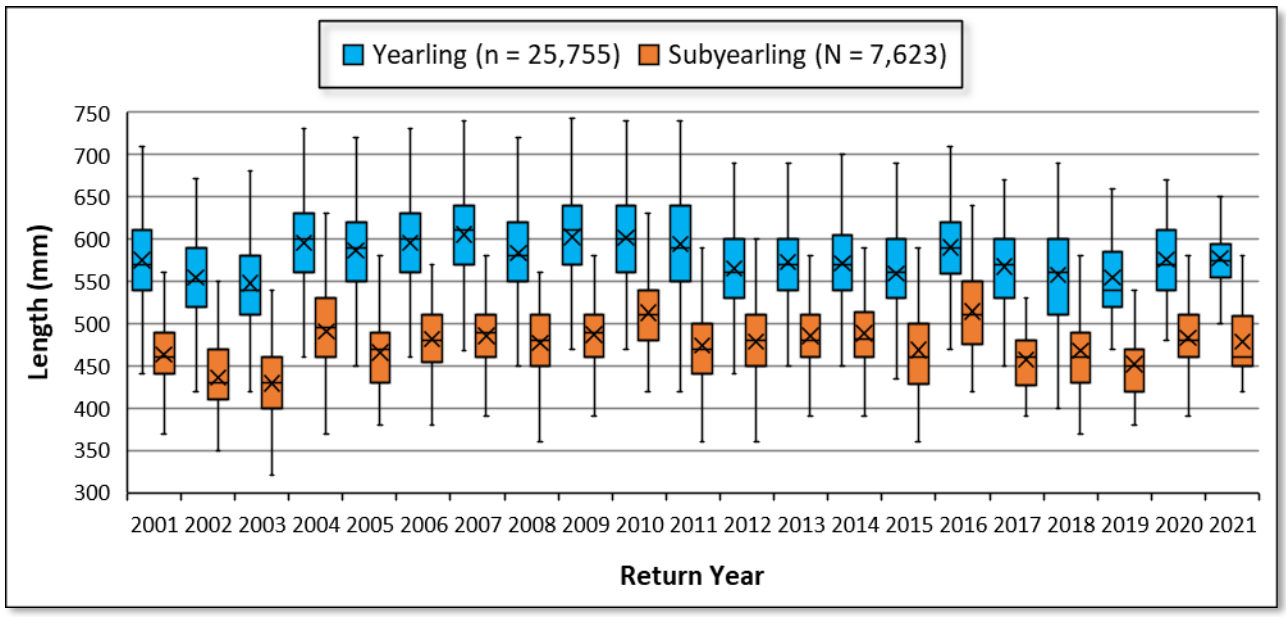
Appendix D, Table D4. Estimated additional production of subyearling Snake River fall Chinook Salmon (at various locations) to replace the current releases of yearlings at Lyons Ferry Hatchery (2006-2019 Release Years).

Release Group	Current Production	Additional Subyearling Production	Total Subyearling Production	SAS (%)	SAS Returns	SAR (%)	SAR Returns	AG [a] (%)	AG Returns
Pooled Survival Estimates (2006-2019 Release Years)									
LFH 1+	450,000			2.41%	10,845	1.51%	6,795	0.30%	1,359
LFH 0+	700,000	1,178,804 [b]		0.92%	10,845	0.64%	6,795	0.26%	1,359
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	0.92%	4,600	0.64%	3,200	0.26%	1,280
GRR 0+	200,000	300,000	500,000	0.53%	1,590	0.32%	960	0.31%	931
BC 0+ 2nd Rel	200,000	200,000	400,000	0.86%	1,720	0.56%	1,120	0.54%	1,086
CCR 0+	0	371,500	371,500	0.79%	2,935	0.50%	1,858	0.49%	541
Totals					10,845		7,138		5,099
Gains/Losses	***-450,000 (1+)***	***1,371,500 (0+)***			***0***		***343***		***3,740***
Mean Survival Estimates (2006-2019 Release Years)									
LFH 1+	450,000			2.41%	10,836	1.52%	6,820	0.30%	1,364
LFH 0	700,000	1,070,225 [b]		1.01%	10,836	0.70%	7,525	0.28%	3,010
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	1.01%	5,062	0.70%	3,516	0.28%	1,406
GRR 0+	200,000	300,000	500,000	0.54%	1,620	0.32%	960	0.31%	931
BC 0+ 2nd Rel	200,000	200,000	400,000	0.96%	1,914	0.58%	1,159	0.56%	1,124
CCR 0+	0	295,500	295,500	0.76%	2,241	0.49%	1,453	0.48%	1,409
Totals					10,837		7,087		4,870
Gains/Losses	***-450,000 (1+)***	***1,295,500 (0+)***			***1***		***267***		***3,506***
Geomean Survival Estimates (2006-2019 Release Years)									
LFH 1+	450,000			1.66%	7,448	0.99%	4,469	0.20%	894
LFH 0	700,000	1,094,997 [b]		0.68%	7,448	0.45%	4,981	0.18%	1,992
Proposed Additional Subyearling Production to Replace the LFH Yearling Release									
LFH 0+	700,000	500,000	1,200,000	0.68%	3,401	0.45%	2,274	0.18%	910
GRR 0+	200,000	300,000	500,000	0.39%	1,170	0.21%	630	0.20%	611
BC 0+ 2nd Rel	200,000	200,000	400,000	0.70%	1,398	0.40%	794	0.39%	771
CCR 0+	0	269,500	269,500	0.55%	1,481	0.33%	891	0.32%	865
Totals					7,449		4,590		3,156
Gains/Losses	***-450,000 (1+)***	***1,269,500 (0+)***			***1***		***121***		***2,262***

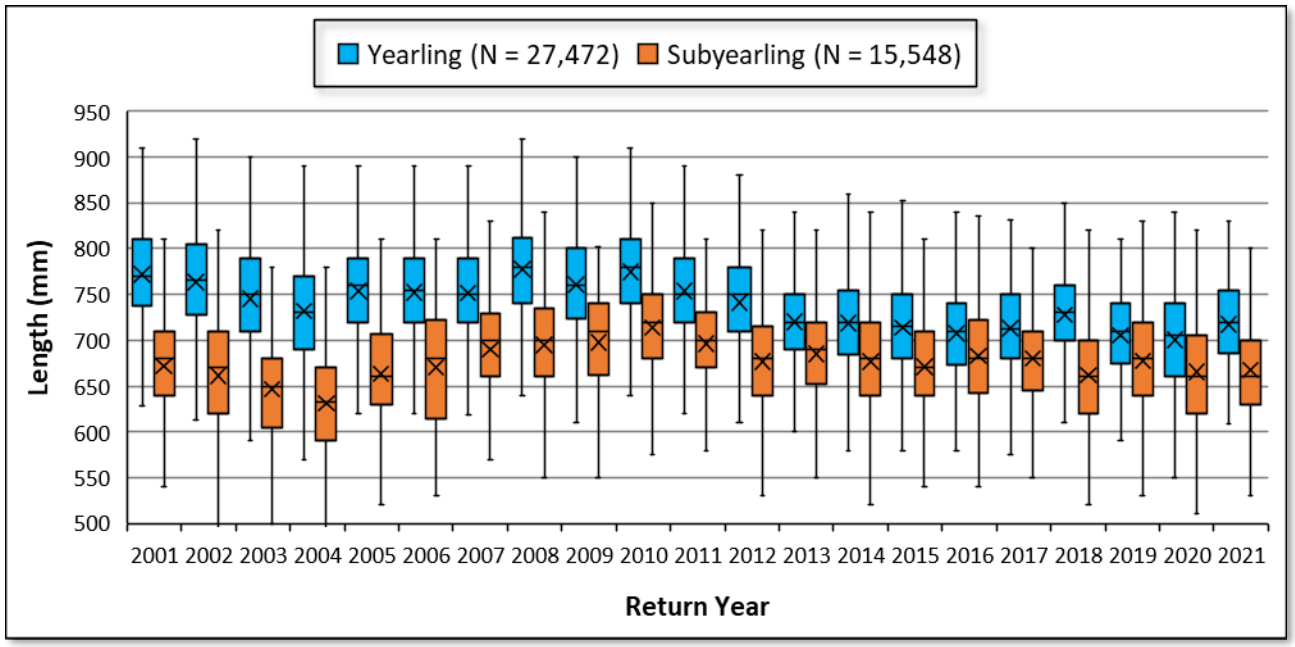
[a] AG = Above Lower Granite Dam. Based on the Radio Telemetry Study conducted from 2013-2017 (Cleary et al.), and from PIT Tag Conversions from Ice Harbor to Lower Granite, approximately 20% of the yearlings from LFH, 40% of the subyearlings from LFH, and 97% of the other releases above Lower Granite are estimated to return to and stay above Lower Granite on an annual basis.

[b] This is the number of LFH released subyearlings it would take to replace the 450,000 yearlings. Since LFH can only release another 500,000 on top of current production (700,000), then the additional production must occur elsewhere.

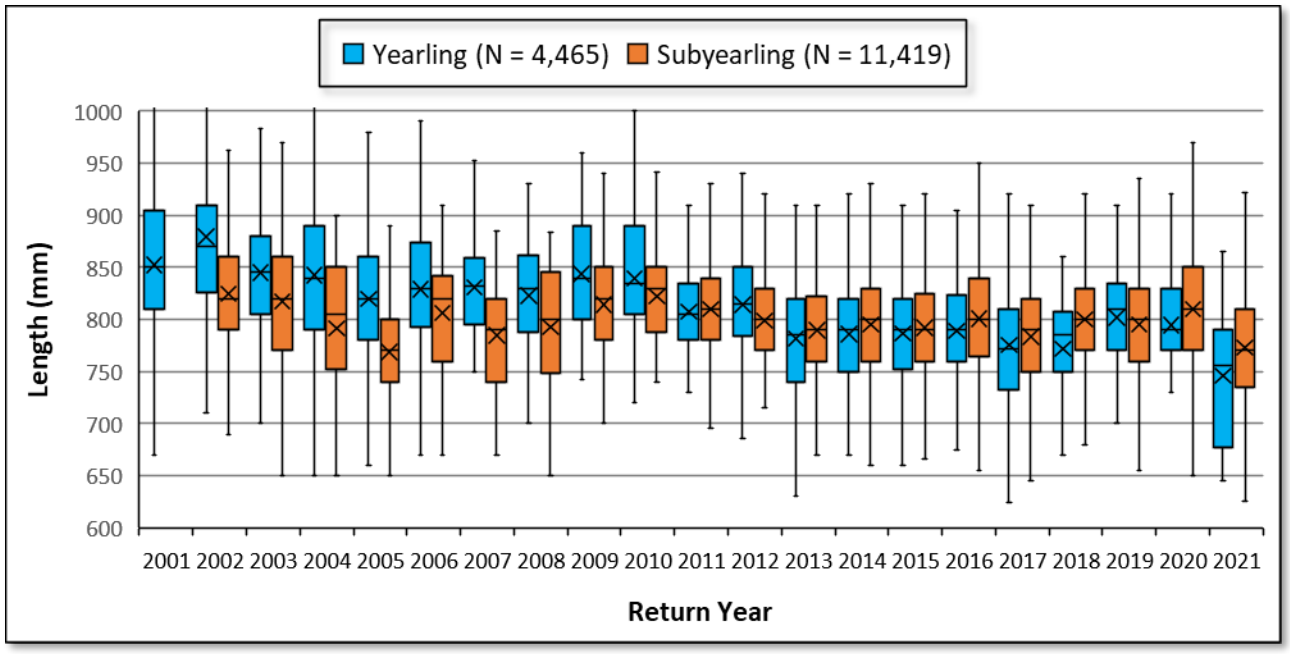
Appendix E. Size (length mm) from yearling or subyearling SRFCH releases (all release locations combined) from 2001 to 2021



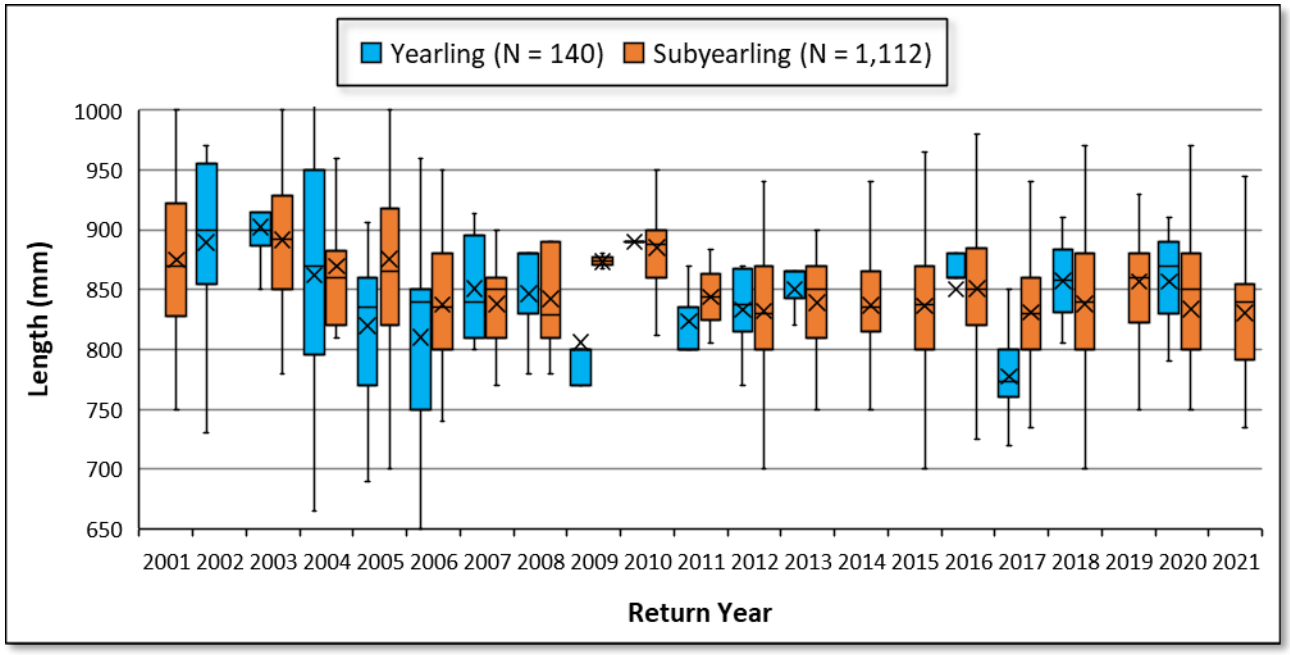
Appendix E, Figure E1. Box-whisker plots by size for yearling and subyearling 1-salt (jacks) aged Snake River Fall Chinook Salmon (2001-2021).



Appendix E, Figure E2. Box-whisker plots by size for yearling and subyearling 2-salt aged Snake River Fall Chinook Salmon (2001-2021).

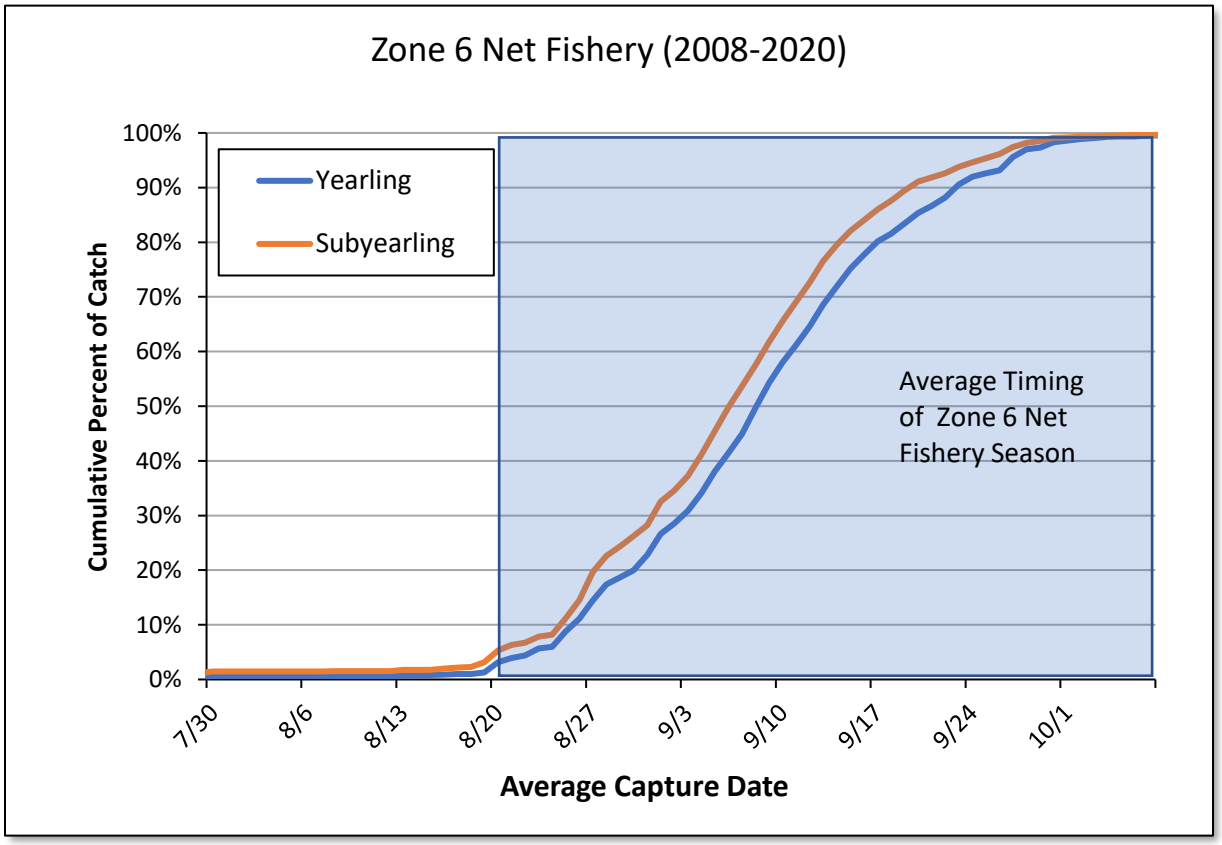


Appendix E, Figure E3. Box-whisker plots by size for yearling and subyearling 3-salt aged Snake River Fall Chinook Salmon (2001-2021).

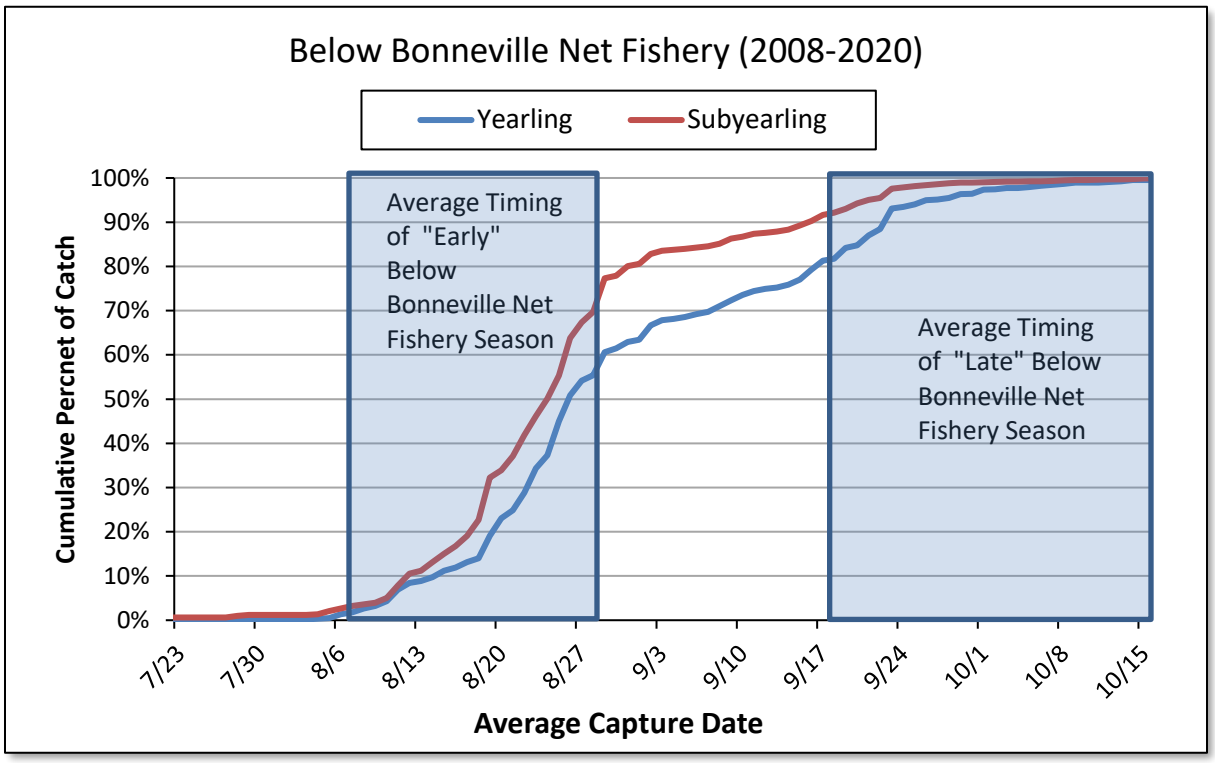


Appendix E, Figure E4. Box-whisker plots by size for yearling and subyearling 4- and 5-salt aged Snake River Fall Chinook Salmon (2001-2021).

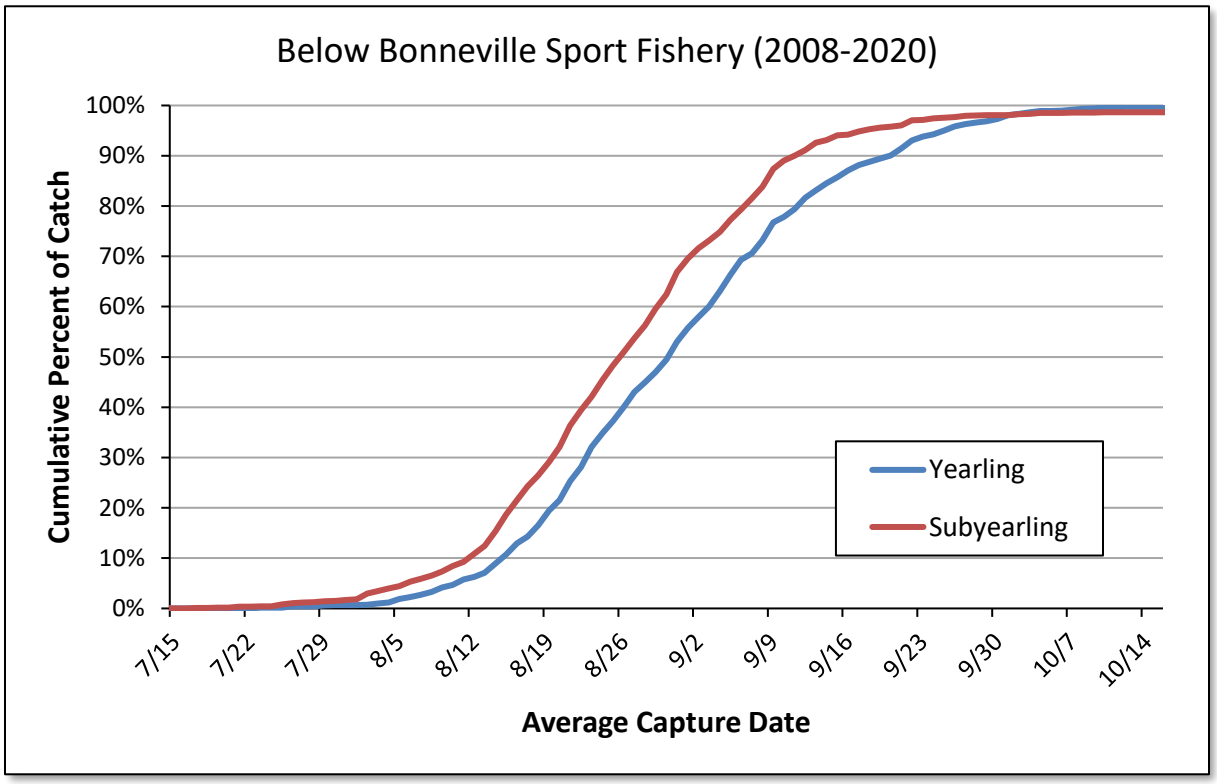
Appendix F. Catch Timing of Yearling or Subyearling Snake River Fall Chinook Salmon (jacks or adults) into the Zone 6 Tribal Net, Below Bonneville Non-Tribal Net, or Below Bonneville Sport Fishery (2008-2020 Return Years) – All Release Groups Combined.



Appendix F, Figure F1. Catch timing of Snake River Fall Chinook Salmon yearlings and subyearlings in the Zone 6 Tribal Net Fishery, 2008-2020 return years.



Appendix F, Figure F2. Catch timing of Snake River Fall Chinook Salmon yearlings and subyearlings in the Below Bonneville Non-Tribal Net Fishery, 2008-2020 return years.



Appendix F, Figure F3. Catch timing of Snake River Fall Chinook Salmon yearlings and subyearlings in the Below Bonneville Sport Fishery, 2008-2020 return years.

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